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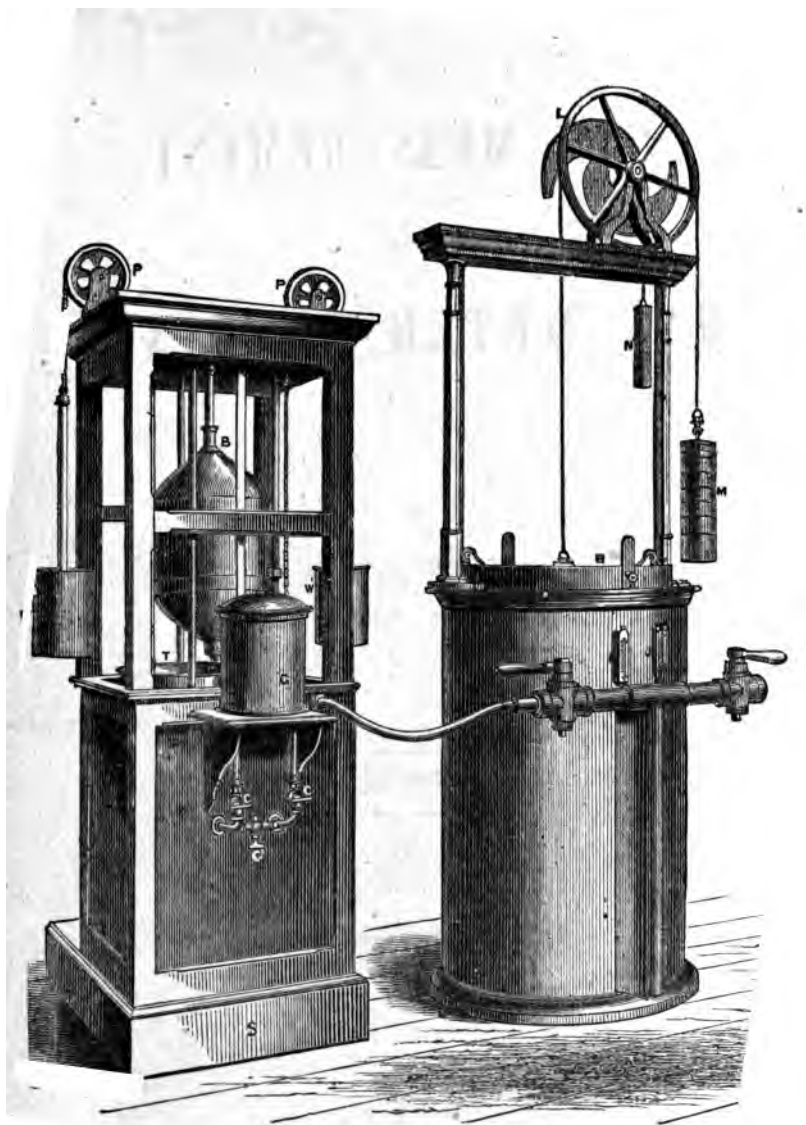
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GAS MEASUREMENT

F. W. HARTLEY.

1





GAS MEASUREMENT

AND

GAS METER TESTING.

BY
F. W. HARTLEY, A.I.C.E.,
HON. M. GAS INSTITUTE.

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P R E F A C E .



A CONSIDERABLE part of the matter contained in this little book was first published in the year 1862, under the title of "GAS METER TESTING," and the ready Sale of that Edition satisfied me that by its issue I had really met a pressing want. Two other editions followed the first: the book with each issue being extended somewhat in its matter, so that during twenty years three thousand copies have been exhausted, while it is still in demand. Having regard to the purely technical character of the Work, this is a somewhat surprising fact, but one which is very satisfactory to me.

The present Edition contains much more in the way of general information than its predecessors, and if it be found that much of such information is merely historical, and much of it purely elementary, I trust none of my readers will think worse of the book on that account, but remember that this, like most text books, is intended to instruct those who are not well informed, as well as to serve as a reference book to those who are so.

F. W. HARTLEY.

London, July 12th, 1882.



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GAS MEASUREMENT

AND

GAS METER TESTING.

1. It is a remarkable fact in the history of gas-lighting in this country, that although Gas Companies at the outset adopted the *cubic foot* as the unit for gas measurement, and, when meters were introduced, actually sold gas under the authority of their respective Acts of Parliament at rates due to a 1000 cubic feet, there should have been no cubic foot measure, or any gas measure included among the standard measures of the nation, and that gas measures of all kinds, inclusive of gas meters, should have remained until the year 1861 altogether exempt from any official verification, such as all other measures of capacity, &c., were subjected to by law.

2. Notwithstanding the non-existence of an official standard measure of the capacity of a cubic foot, the weight of water equal in bulk to a cubic foot, had been determined, and consequently water had been used in various ways down to the year 1861 as an agent for ascertaining the capacity of, and for graduating instruments to be used for measuring gas.

3. Previous to the year 1861, many, if not most, persons who were concerned in making Gas Measures, adopted 62.5 lbs. as the weight of water equal to the bulk of a cubic foot, although it was known that Kater's experiments showed that at 62° Faht., and with the barometer at 30 inches, the weight of a cubic foot of pure distilled water weighed in air was 62.321 lbs. avoirdupois.

Ordinary water, which is denser than distilled water, was, however, usually employed by the makers of measures; but then no care was taken to free it from air by boiling before use, so that the greater density which would diminish the bulk of 62.5 lbs., was, to an uncertain extent, compensated for by the presence of air which would lessen the specific gravity of the water. So that when measurement was effected by the aid of water actually weighed under normal conditions, there existed no reason for grave differences in the derived measures of various makers. There can be little doubt, however, that some operators when using and weighing water were indifferent alike to its temperature and to atmospheric pressure, and were, it may be, still less regardful in respect to equality in the temperature of both air and water when graduating gas measures. Another source of difference was that while some determined cubic capacity by *weighing* the water, others did so by *measuring* the water. Certain it is that from various causes, test-gasholders differed to an important extent from each other in capacity throughout the kingdom, although it might be that in a particular district test-gasholders closely agreed with each other.

4. Water, as already stated, was used in various ways prior to 1861 to ascertain and define the capacity of a cubic foot in gas measures. Doubtless in more ways than are herein described, as the Author deals only with those which he himself has used.

METHODS OF GRADUATING GAS MEASURES PRIOR TO 1861.

5. In fig. 1 the bell of a test-gasholder (17) is represented in an inverted position, the top or crown resting on a firm and level base. At A a socket piece was soldered or attached to the bell, and rising from this was a fine-bore glass tube T, the junction at A being made sound by a stuffing box. This arrangement put the glass tube into communication with the

interior of the bell. All being ready, water was poured into the bell until it rose, say, 3 inches in the tube. When the water had become quiescent, its height was marked on the

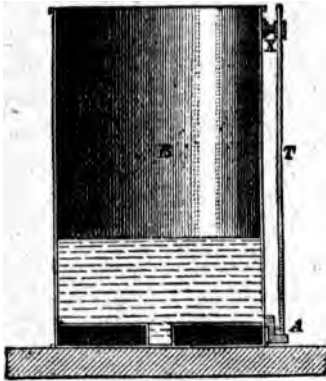


FIG. 1.

tube by means of a narrow strip of gummed paper. Two measures were employed, viz., a standard gallon and a standard quart, each having a neck for the use of a striking plate. The gallon was filled and emptied into the bell six times in succession, then the quart was also filled, and likewise emptied into the bell. When the water again became quiescent, the new level was marked on the glass

tube. These operations were repeated until as many divisions as were required were marked off towards the point X. The bell was then emptied of water, the bracket above X and the socket, A removed, and the hole in the side of the bell closed. The extreme lines on the glass tube were then marked on the bell in their proper positions, and the bell mounted to its tank. The latter being charged with water to the proper level, the line, which was the upper one on the glass tube, became the lower on the bell when in its right position, and this lower line was made to coincide with the water level in the tank. The depth from the top edge of the tank to the water level was then carefully measured. The bell was next immersed in the water until the second line coincided with the water level. The depth from the edge of the tank was again measured, and was necessarily less than before. The difference, of course, represented the amount of displacement of water caused by the thickness of the metal of the bell.

This difference between the two measurements had to be subtracted from the scale length, as determined by the actual measurement by water of the bell itself, and for this reason:—The displacement, and consequent rise in the height of the water in the tank caused by the immersion of the bell (and operating *within it* as well as in the tank), led to the discharge of a greater volume of gas than could be indicated by a scale based upon the actual measurement of the capacity of the bell, whether such scale was (1) attached to the pillar of a gasholder, and the index pointer fixed to the bell so as to rise and fall with it, or whether (2) the scale was attached to the bell so as to rise and fall with it, and the index pointer fixed upon the edge of the tank.

6. About thirty-two years ago Mr. A. Wright constructed several *one* cubic foot holders, which were about 7 inches in diameter and of great length. The capacity of these had been determined in the way described, but the *water line* in the tank formed the index or reading point, the scales being on the bells and a window being in the side of the tank, hence no subtraction had been made from the gross or determined length of stroke. Such holders were only useful for special purposes and the objection to them is, that they require great height, and unless specially protected from the influence of the warmer air of the upper part of the chamber in which they are placed, are apt to induce errors in measurement. The building in which they were used permitted due precautions to be adopted. With gasholders of the usual sizes and therefore of considerable diameters grave errors would have resulted had the water line been adopted as the index or reading point.

7. The Author found the system of measurement just described so troublesome and laborious that he only graduated one 10 cubic feet gasholder in this way, and then resorted to the method next described.

8. A vessel P, fig. 2, used as an aspirator, was filled with

water through the funnel and cock C. The opening A was connected by a flexible tube to the standpipe cock of a gas-holder, the bell of which had been accurately balanced, and the loss of weight of which in its descent into the water was com-

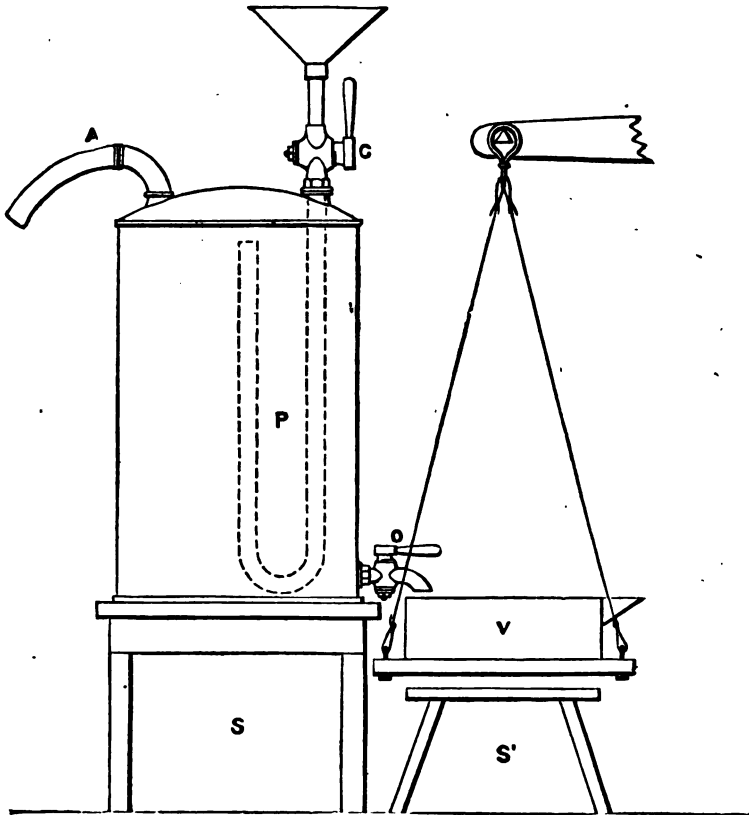


FIG. 2.

pensated for by a weight in the way described in paragraph 21. The gasholder being raised out of the water of the tank to the extent needful to leave sufficient water seal at its lower or open

end, and being in communication with the aspirator through A, the cock C was closed, and water was drawn off from the cock O into the vessel V, which was opposed at the other end of a scale beam by a counterpoise and by weights equal to 65.5 lbs. avoirdupois, ordinary water being used. When the scale beam came into equilibrium, the cock O and the gasholder cock was closed, V was emptied, and P, which contained about two cubic feet, was re-filled with water, and the operation repeated as many times as was necessary. The intended scale being attached to the holder was first marked with a zero line and with an additional line on the abstraction of a cubic foot of air. In this way a scale requiring no correction was produced, and Test-Gasholders so graduated by the Author were, after some years of use, found in 1861, when tested by a duplicate of the Standard Cubic Foot Measure (16), to be within the limit of error then allowed by the Standards' Department, namely, *half per cent.* A variation of this method was also practised by the Author. The funnel above the cock C, fig. 2, was replaced by a cylindrical vessel with a conical bottom, which held a little more than a cubic foot of water, and with C closed, six gallons and one quart of water were poured into the upper vessel. The chamber contained air only, and being in connection through A with the gasholder to be tested (the bell of which, in this case, was immersed to the lowest point of its required stroke, in the water of the tank) and the cock O being closed, C was opened and the water flowed into P through the syphon pipe shown by the dotted lines, expelling air and driving it into the gasholder bell. In the former case the scale was found with a descending and in the latter case with an ascending bell. The latter method gave less reliable results than the former.

9. Mr. Alfred King, of Liverpool, at a date unknown to the Author, but which must have been considerably anterior to the year 1856, devoted his energies to the production of a

Standard Cubic Foot Measure and the result of his conceptions and efforts is shown in fig. 3. A, is an upper vessel, of

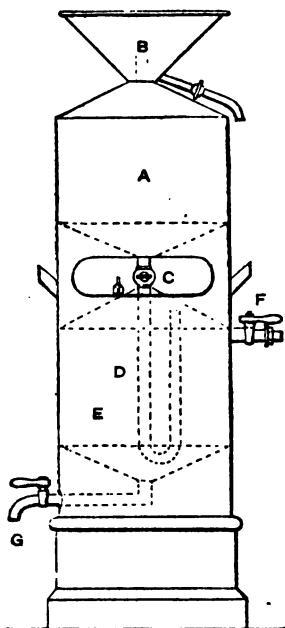


FIG. 3.

the capacity of one cubic foot, with conical ends, terminating in necks, the lower having a stopcock C, to which is attached a syphon tube D, descending into a lower vessel or air holder E, of similar shape to A, provided with a stopcock at F for permitting the escape of air, and at G with another stopcock for the withdrawal of water. B, is a funnel surmounting A and provided with a pipe and stopcock. This instrument was called a transferrer, and the method of using it for graduating a test-gasholder was as follows:—First close all the cocks, and fill the upper vessel with water, open the cocks F and C and thus allow the water to run into the lower vessel E, then close

C, draw off the water from G, and return it into the upper vessel A. Repeat this operation several times, so that the water and the instrument become of the same temperature. At the last filling, strike the water off the surface of the upper neck of A with a perforated glass, so that there be no bubble of air under it, leave it in that state for five minutes and if no air bubble appears, the upper vessel may be deemed sound; then attach F to the gas-holder to be tested, close all cocks except between the gasholder and the transferrer, and with holder about half filled with air, cause it, by removal

of counterpoise weights, to give 3 inches pressure, mark the scale or intended scale of the gasholder at a point opposite the index, and if the gasholder bell remains in the same position for five minutes the connections are sound. Put the bell of the gasholder in perfect balance by replacing the counterpoise weights which have been removed; then open C and allow the water from A to descend into E; listen for the time when it ceases to run, then note the clock and wait five minutes to allow for drainage of the upper vessel, then close C. With F closed and a vent cock (not shown in the woodcut) open, draw off the water from G and return it to A with sufficient in addition to cause the level to be above the neck of A, draw off the excess by the side cock, strike the water with the glass across the neck as before, open F and C, and so proceed until the gasholder scale is formed: marks, as in the former illustrations, being made after each delivery of air into the bell.

10. These various methods of using water are, as will be readily realized, both slow and exceedingly laborious, for more than 62 lbs. of water had to be weighed, measured and lifted for every cubic foot of air measured; and it will be hereinafter shown how much more facile and rapid the methods are, which have been practised since the year 1861.

THE SALES OF GAS ACT.

11. In the year 1859 an Act was passed entitled "An Act for Regulating Measures used in Sales of Gas." This Act was modified by two subsequent Acts, which deferred the date at which it was to come into operation, changed some of the authorities who were to carry its provisions into execution, and finally rendered its application permissive instead of compulsory—dependent, in fact, upon the resolutions of magistrates and

other local authorities. As a consequence of the last alteration, many of the authorities neglected to adopt the Act from considerations, it may be, of the attendant expences. Nevertheless the Act is virtually in operation all over the kingdom, for very few meters are put into use without having been previously verified and stamped by a Public Inspector.

12. In the original Act it is enacted that—

CLAUSE II. After the passing of this Act, the only legal Standard or Unit of Measure for the Sale of Gas by Meter shall be the Cubic Foot, containing 62·321 Pounds, Avoirdupois Weight, of Distilled or Rain Water weighed in Air at the Temperature of Sixty-two Degrees of *Fahrenheit's* Thermometer, the Barometer being at Thirty Inches, except as relates to Contracts made before the passing of this Act by which a different Unit of Measure is adopted, which Contracts may not be renewed.

CLAUSE III. Within Three Months next after the passing of this Act, Models of Gasholders measuring the said Cubic Foot, and such Multiples and Decimal Parts of the said Cubic Foot as the Lord High Treasurer or the Commissioners of Her Majesty's Treasury of the United Kingdom for the Time being shall judge expedient, and, from Time to Time after the Expiration of the aforesaid Period of Three Months, Models of such further Multiples and Decimal parts of the said Cubic Foot as the Lord High Treasurer or the said Commissioners shall from Time to Time think expedient, shall be carefully made, with proper Balances, Indices, and Apparatus, for testing the Measurement and Registration of Meters, and such Models shall be verified under the direction of the Lord High Treasurer or the said Commissioners, and when so made and verified shall be deposited in the Office of the Comptroller General of the Exchequer at

Westminster; and copies of the Models so from Time to Time deposited, verified as aforesaid, shall be sent to the Lord Mayor of *London*, and the Chief Magistrate of *Edinburgh* and *Dublin*, and to the Chief Magistrate of such other Cities and Boroughs and to such other places and Persons in Her Majesty's Dominions as the said Lord High Treasurer or the aforesaid Commissioners may from Time to Time direct; and the said Lord High Treasurer or the said Commissioners shall appoint a competent Person or Persons to design and make, subject to the Approval and by Direction of such Lord High Treasurer or the said Commissioners, Stamps of a uniform Design to be used for stamping Meters throughout the United Kingdom, with only such Variations of Numbers or Marks thereon as shall be sufficient to distinguish each Inspector's District.

13. The clauses which follow the foregoing relate to the appointment of meter inspectors, the models, or copies, of the standard measures to be used in testing meters, the verification of meters, fees for such verification, &c., &c.

14. In accordance with the provisions of the third clause, the following standard of cubic capacity were accordingly constructed under the direction of the Astronomer Royal, namely, a measure of such capacity as to contain 62·321 lbs. of distilled water at the temperature of 62° Faht., and with the barometer at 30 inches (which measure is usually called the *cubic foot bottle*), and three *gasholders* of the respective capacity of *one and one-tenth*, *five and five-tenths* and *eleven* cubic feet. In 1871 the Royal Commissioners of Weights and Measures increased the number of gas measures by including GAS METERS of a very perfect character as secondary standards (24).

STANDARD GAS MEASURES.

15. THE CUBIC FOOT MEASURE, or unit.

GASHOLDERS, containing more than a cubic foot.

GAS METERS of special construction.

16. THE CUBIC FOOT MEASURE, or *Bottle*, as it is usually called.—This is shown in fig. 4, and is an outcome

FIG. 4.

of Mr. Alfred King's Transferrer, shown in fig. 3, for the form of the bottle is practically identical with that of chamber A of his transferrer; and to that gentleman the credit is due of having been the suggestor of a form of vessel so well suited for the purpose, and which is so little liable to have its form and therefore capacity altered by moderately rough usage.

17. GASHOLDERS.—The Government Standards are very elaborately finished and beautiful instruments, far too costly for general use. In principle of construction, they are identical with those employed by Public Inspectors and others for the verification of gas meters in this country, in the colonies, and abroad. By these standards, the working or "Inspection Standards," as they are called, are verified, and the divergence, or error in the latter, must not now exceed a quarter of a per cent., only one half the error formerly allowed, but which is nevertheless amply sufficient. The description which follows applies *especially* to "Inspection Standards," and generally to the Government Standards.

18. An instrument of this kind, fig. 5, consists like an ordinary gasholder, of a *water tank* and a cylindrical *bell* or *holder* fitting into the tank. The holder is free to rise to a certain height, and is made to contain a specific volume of air or

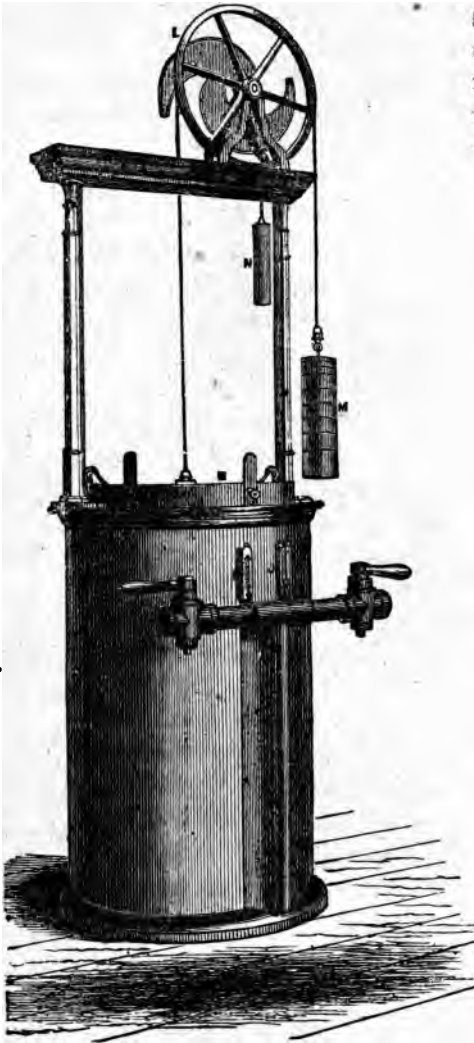


FIG. 5.

gas, and it is constructed in such a manner as to fulfil the following conditions, viz.:—

- (1.) *The vertical descent of the holder while its contents are being discharged.*
- (2.) *The adjustability of its operating weight, so that it shall deliver gas at any pressure up to a pressure equal to 3 inches head of water.*
- (3.) *The uniformity of its pressure, whatever it may be throughout the descent of the holder.*
- (4.) *Great accuracy in its measurement.*

19. The vertical descent of the holder is secured by affixing to the top and bottom of the holder a certain number of guide-wheels. Those at the top of the holder run against pillars, which rise from the edge of the tank, while the bottom wheels run against guide-plates within the tank.

20. Secondly the holder is made heavier than is requisite for it to give the maximum pressure, and is suspended from the end of a cord or strap, which passes over the grooved wheel on the beam above the pillars, and sustains also a series of counterpoise weights, the removal of one or more of which causes the holder to discharge its contents at pressures ranging from one-tenth of an inch up to 3 inches head of water.

21. In respect to the third condition, it is to be remarked that when the holder is immersed, it necessarily displaces a quantity of water equal to the bulk of the metal composing the holder's circumference. If we assume the specific gravity of this metal to be seven times that of water, and its bulk to be one-tenth of a cubic foot, then the weight of the metal immersed would be 43.62 lbs., one-seventh of which, or 6.23 lbs., would be the weight of the water displaced, and also be the weight which the holder would lose by immersion. To compensate for this loss and to render the pressure of the holder equal throughout its descent, a spiral curve and a weight are employed. The spiral is formed upon, and curves inwards nearly to the centre of, a metal plate, which is fixed on to the end of the spindle upon which the large grooved wheel revolves. The weight, which is proportioned to the compensation required, is suspended by a cord from the outer end of the spiral. When the holder is raised to its greatest elevation, the weight acts with its greatest force. As the holder descends the large wheel partly rotates, and the spiral is also turned, so that the cord approaches the centre, the leverage thereby becomes less, and the effective "pull" of the compensating weight diminishes in exact pro-

portion to the weight lost by the holder throughout its descent into the water. Formerly the compensating curve was made with *one* arm only, and its varying leverage, as it changed its position by rotation, caused irregularities in the pressure given by the holder. To obviate this evil, the Author about 24 years ago constructed the compensated, or two-arm, curve shown in the wood-cut.

22. Gas or air is admitted to and discharged from the holder through a *stand-pipe*, which is fitted to the front of the tank, and also passes up the centre of the tank to a few inches above the water line. The front or *external* part of this pipe is fitted with two cocks, and with a pressure-gauge and a thermometer to show the pressure and temperature of the issuing gas. It is also provided at the lower part with a socket and plug, so that any water which may by accident have entered the pipe may be drawn off. The tank is further provided with a cock at the water line, and with another at the base for discharging the water when needful.

23. Accuracy in measurement is secured by filling the bell of the gasholder with air, by successive discharges from an exact duplicate of the government cubic foot bottle (in the way hereafter explained), marking the elevation of the bell, for each cubic foot of air thus delivered into it, on two vertical scales, one affixed to the front, and the other to the back of the bell. The primary divisions thus determined are sub-divided so as to indicate *tenths* and *hundredths* of a cubic foot. When the gas-holder is properly levelled and adjusted, the relative divisions on the two scales will agree, but if the holder be not levelled and adjusted properly, the divisions will not coincide.* In practice the front scale alone is generally regarded. In order

* Sometimes the tank is provided with levelling screws on its base.

to enable the scales to be accurately observed, a pointer or some other appliance is fixed upon the tank opposite each scale.

24. GAS METERS.—The standard test-meters are respectively

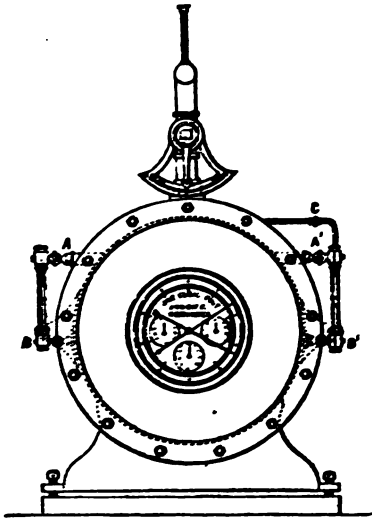


FIG. 6.

20-light and 100-light size, of the wet kind, fig. 6, and were made under the direction of the Author in accordance with a design submitted by him to the Royal Commissioners. The measuring wheels of these meters are made of very stout incorrodible metal, and the cases are lined with the same metal one-eighth of an inch thick, so that the meters are as durable as the other Government standards which relate to gas measurement. Each of these meters is provided

with *three* water level gauges, and with adjusting screws in the feet, so that it can be set to a true level with the utmost facility. One of the gauges is also so arranged that the outlet gas pressure may be allowed to act within it, through the cock A' or the inlet gas pressure through the pipe and cock C, thus enabling the operator to adjust the water line, either when the meter is at rest or when it is in action. The index of each meter is centrally placed, and its dial is circular. The indications of quantity range from one-hundredth of a cubic foot up to 1000 cubic feet, and the pointers can be shifted backwards and thus set at zero without the necessity for working the meter, or of stopping the passage of gas through it if the meter be in action.

25. Each meter is also provided with a nosepiece union on

its inlet for the attachment of tube, and its outlet is surmounted by a bend, also terminating in a nosepiece. A thermometer is inserted in a socket on the bend, so that the temperature of the issuing gas may be readily observed, while the rate of issue is controlled by a cock furnished with an index, so that after having been closed, the cock may be readily re-opened to the desired extent.

The extreme dimensions of the meters are :—

20-LIGHT.		100-LIGHT.	
Diameter	. 2' 2"	Diameter	. 3' 8"
Depth	. . 1 6	Depth	. . 2 6
Height	. . 2 2	Height	. . 3 8

26. Test meters should generally, in their construction and details, agree with those just described, but need not by any means be so elaborately finished and expensive. As usually made, a Test-meter has only one water gauge, and the levelling is determined by means of spirit levels fixed upon the top of the meter.

27. Dry meters also of the respective sizes of 20 lights and 100 lights were, by the recommendation of the Royal Commissioners on Weights and Measures, obtained for the Standards Department, but these certainly cannot be regarded as Standard measures, and the Author cannot but think that the Commissioners made a grave mistake in suggesting that they should be had. Certain it is that no inspector who possesses any practical knowledge of meters would think of using a dry meter for testing purposes, even if such meters were likely to stand the process of verification at the Standards Department. The most material reasons against the dry meter and in favour of the wet, for *testing purposes*, are as follows, and these reasons were submitted by the Author to the Warden of the Standards in July, 1870:—

28. *Dry Meter.—Reasons against.*—The measuring-chambers are composed partly of flexible material; and measurement is,

moreover, dependent on the preservation, under all conditions of use, of the absolute soundness of the slide-valves, by which gas or air enters into, and is discharged from the measuring-chambers. The dry meter is subject to disturbing influences, which alter its measuring capacity, and the existence of such disturbing influences could not be known at the time of using the meter, or even before or afterwards. The meter might, under conditions apparently identical, or at all events under such conditions as an inspector could use it, vary to the extent of 2 or 3 per cent., and the inspector know nothing of such variation. No means can be devised which will enable a dry meter to give internal or external evidence of its measuring condition, and therefore it would become necessary, if the dry meter were used for testing purposes, to re-verify it at frequent intervals.

29. *Wet Meter.—Reasons for.*—The measuring-wheel of a wet meter is composed of inflexible material, and is practically incapable of any variation in capacity, except that produced by the elevation or depression of the water level. The measurement is moreover, independent of any valves whatever. It is free from any influences capable of disturbing its measurement when used under conditions which the inspector can command and control. It affords internal evidence of its own measuring condition, for the wheel being inflexible and unchangeable as to dimensions, and the depth of its immersion being defined by lines upon water-level gauges, it follows that it is only necessary to charge the meter, on every occasion of using, to the lines on the gauges, to secure optical evidence of the meter's measuring condition; hence re-testing at frequent intervals is unnecessary.

30. Test-meters were rendered legal secondary standards by an Order in Council, dated 24th March, 1871, and the issue of that Order was a source of much gratification to the Author,

who had for years been an advocate for the use of test-meters. In the first edition of this book, published in 1862, he said—
 “that such meters would be of the greatest utility for testing
 “large meters which are fixed and in use at public buildings,
 “factories, &c,” which meters cannot be removed to the Inspector’s office, except with great difficulty and expense.

31. The special advantages possessed by a test-meter are its moderate dimensions, and the consequent facility with which it can be transported to, and deposited for use in, places where a gasholder is inadmissible; the ease with which it may be used; and the greater accuracy in the results over those obtainable by the employment of a gasholder under necessarily exceptional conditions. With the latter it is impossible to maintain a continuous discharge of gas or of air through a large meter. It is, however, to be distinctly understood, that a test-meter can never be accepted and employed as an efficient substitute for the gasholder in the offices of meter inspectors, of meter makers, or of gas companies, inasmuch as it is incapable of adjustments which would cause it to deliver gas at different and specific pressures; for although it would be easy to provide means for such adjustments by the application of a water-wheel, of clockwork, or of a pulley and weight, in connection with the shaft of the measuring wheel, such application is certainly objectionable and would interfere with measurement. Hence, with a test-meter, it is not possible to test another meter under any specified conditions as to pressure of gas; but this fact affords no basis upon which objections can be raised to the employment of test-meters for the purpose advocated.

32. In order to demonstrate the accuracy with which a meter may be tested by another of smaller size, the following experiments were made:—

(a) A small wet meter was carefully tested by discharging through it, at the exact rate due to its capacity, the entire

quantity of air which a gasholder contained within the limits defined by its scale. *The meter was found to agree exactly in measurement with the gasholder.*

(b) The meter was then connected to a meter of ten times greater measuring capacity, and of precisely the same construction as a station-meter, but without an overflow water-gauge, the water-line being defined by a socket opening, and the water-level being adjusted when the meter was out of action. Gas was then passed through both meters in a continuous flow at the precise rate at which the smaller meter had been tested, until the measuring-wheel of the larger meter had made several revolutions, as indicated by the index. *The registration of the meters was found to be in perfect agreement.*

(c) The larger meter was then tested at the rate due to the small meter, and with the same holder which had been used to test the small meter, and *was found to agree exactly in measurement.*

(d) The larger meter was then tested with the same holder at higher rates of working, and it slightly and regularly altered in its registration, until, on being worked at its proper speed, and when therefore delivering its proper quantity of gas, the change amounted to the *insignificant error of of one per cent. slow.*

33. The greatest possible care was taken in these experiments, which were many times consecutively repeated, to preserve equality of temperature in the water, in the gasholder and meters, and in the air employed.

34. With such facts as the above before his eyes—facts which the Author has repeatedly verified—with a knowledge of the manner in which inspectors use, and are *obliged* to use, gas-holders for testing large meters which are *away* from the testing offices, and with the experience of years in the use of the test-meter, the Author is forced to entertain a conviction that accuracy

is only to be attained, on most occasions, by the use of a test-meter for out of office work, and feels justified in advocating in the strongest terms the employment of a test-meter for such work, and for the purpose of determining the accuracy of large meters generally.

35. As shown in the experiment on the larger meter above-mentioned, a wet meter becomes *slow* to a certain limited degree when worked *above* the speed at which its measuring capacity has been determined. The reverse of this takes place when a meter is worked *below* its speed, and it becomes *fast* to a trifling extent.

36. The reasons for such variations are as follows :—A meter requires power to drive it ; this power must be derived from the gas to be measured, so that the gas must be delivered into and pass through the measuring chambers under some sensible pressure, i.e., in a state of compression greater than that of the atmosphere, and can only be measured while in this greater state of compression. The practical effect of this compression is very small (see end para. 32), but sensible and important differences in measurement arise from the displacement of water from the measuring chambers, which displacement increases as the working speed is increased, owing to the greater resistance of the wheel, and renders the meter *slow*, that is, causes it to register *less* than the true volume passed through it. This fact leads to an important proposition—viz., What are the conditions under which a *test* or *standard wet meter* must be employed, in order to secure the closest approximation to true measurement ?

37. If the capacity of the meter has been determined at its normal rate of working, and the water-level defined by marking the gauges when the meter is not working, and when only the atmospheric pressure is acting within it, then the meter must always be charged with water to the indicated level *when open to the atmosphere* ; and it must always be used at its *normal rate* of

working, or, if worked at other rates, the *per centage of error due to such rates* must be *experimentally determined and allowed for*. Practically, the error due to varying rates is not likely to exceed about *one per cent*.

38. If the capacity of the meter be determined at its normal, or at any rate of working, and the water-line be defined while the meter is *working* at the same speed, and the pressure of the *inlet gas* be acting in the gauges, then the meter can be made to measure correctly at any speed, by the simple process of adjusting the water-line while the meter is working at the rate desired. More water will necessarily be needed in a meter when worked at a high speed, in order to provide for the difference in the levels within and without the wheel.

METHODS OF GRADUATING GAS MEASURES SINCE 1861.

39. The merit of having been the first to contrive a means for transferring a cubic foot of air directly from the cubic bottle into the gasholder to be measured, belongs, the Author believes, to Mr. George Glover, although he (the Author) independently, and without any knowledge of what Mr. Glover was doing, or had done, also devised a method for effecting such transference of a cubic foot of air. Mr. Glover's arrangement is shown in fig. 7. The bottle is suspended upside down from a frame of iron firmly fixed by screws to the upper part of a box, within which is a water tank of somewhat greater depth than the bottle. The tank is suspended by two cords, which pass through pulleys at the top of the iron frame to the barrel of a winch fixed on the lid of the box, the lid being secured in the position shown in the cut by bolts or screws. The plug of the cock of the bottle is removed before it is mounted, and the end of the cock barrel covered by two discs of plate glass, firmly held in

position between brass plates bolted together. Finally a bent pipe, fitted with a stop-cock, is attached permanently to the neck of the bottle, as shown in the woodcut. From this pipe a tube connection is made to the holder to be tested. The tank, being charged with water, is raised by turning the handle of the winch until the whole of the air is expelled from the bottle, and

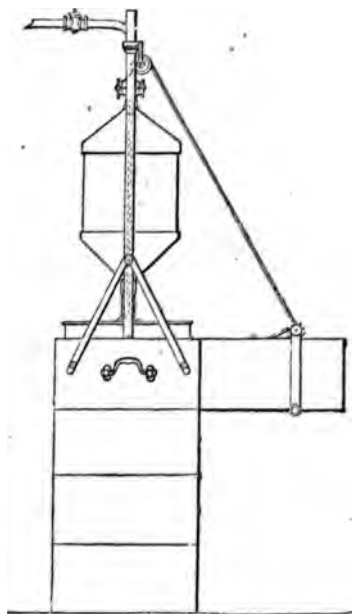


FIG. 7.

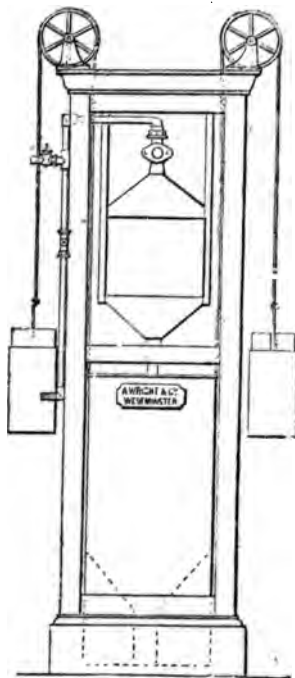


FIG. 8.

water appears in the barrel of the cock between the glass plates; the cock on the bend is then closed, as is also the gasholder cock. An intermediate vent cock on the connecting pipe, and the cock of the pipe on the bottle are opened, and then the tank is lowered to its original position. The operations are repeated as many

times as necessary. To render the instrument portable, the frame and winch are taken off the box, the bottle packed, and the lid closed.

40. The Author's arrangement for using the bottle as a direct

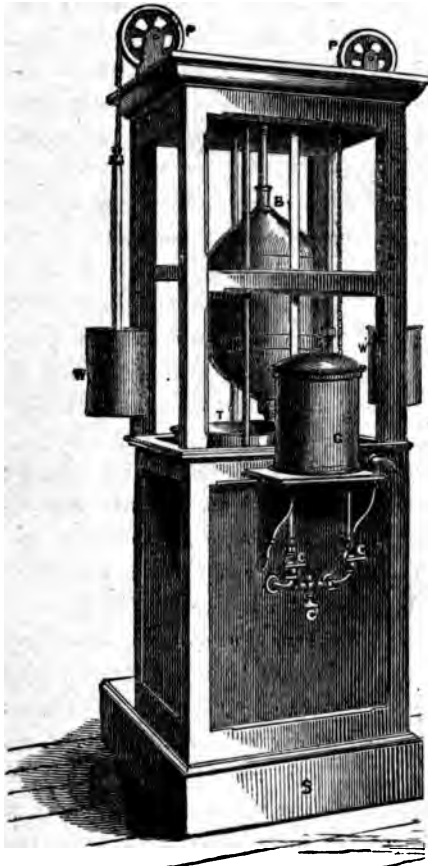


FIG. 9.

B.—Cubic foot measure, open at its lower end and terminat-

transferrer, or measure, is shown in fig. 8, but will be best understood by reference to fig. 9, which represents a standard instrument similar to those which have been made by A. Wright & Co., for the Canadian, the South Australian, and the Dutch Governments.

S.—A strong frame of polished mahogany, with rollers below its base, so as to be easily moveable over a level floor.

T.—A water tank connected by chains, passing over the pulleys P, P', with the counterpoise weights W, W'.

ing above B in a glass tube, connected by stuffing boxes to the upper neck of the measure B, and to the delivery pipes C, C', which terminate in a nose-piece in front of the frame S.* In connection with the pipe attached to the measure, there are, at the back of the Frame S, two cocks, one to cut off the connection of the delivery pipe to the measure when a cubic foot of air has been expelled, and the other to admit air through the glass tube into the measure during the descent of the Tank T.

C, C, C'.—A Bye-pass in the delivery pipes so that the air from the measure may be delivered through C' (C, C, being closed) at unregulated pressure and speed, as when testing a gasholder, or through a wet governor G (C' being closed and C, C, open), at a fixed pressure and therefore at a regular rate of delivery, which is necessary when testing meters with the cubic foot measure.†

41. The Author's method demands but little labour to operate, for in addition to the counterpoises, four loose weights are provided, and by placing these in pairs on W, W', the water tank is caused to rise, and by their removal the tank is caused to descend. The governor is required only when the bottle is used to verify a gas meter, and no error can, or does, arise from its intervention. The governor having been weighted to the needful extent (say to give five-tenths of an inch of water pressure), the bottle, governor, and meter are first connected together by pipes, and their æriform contents brought into equilibrium with the atmosphere. The instant the discharge of air from the bottle commences, the governor comes into action,

* The original form of closed cock barrel has been reverted to in order to avoid stuffing boxes.

† The bye-pass has been much simplified and made more effective.

and when the air has been completely discharged from the bottle, the gasholder of the governor descends and delivers the air which it has received through the meter, and all once more comes into equilibrium with the atmosphere. The system has been severely tested by the Author, and appears both on the grounds of reasoning and of demonstration to be free from objections, while it certainly possesses strong claims on account of its simplicity, the small amount of trouble it demands, and the continued use of the same volume of water, which last may therefore be readily brought to and maintained at a due temperature. It is to be understood, however, that such direct measurement from the bottle is by no means a necessity in the case of a meter, and can only be readily applied to small meters. The method of measuring meters directly by the transferrer, moreover, does not give absolute accuracy, for the cubic foot of the bottle is a cubic foot under atmospheric pressure only; but the error is very small, inasmuch as under a mean barometric pressure, and with a meter or other measure opposing a resistance of so much as half-an-inch water pressure, the reduction in volume would be no more than 1-768th part, or just over $\frac{1}{8}$ th per cent.*

42. By the use of the bottle as a direct transferrer, all the errors which attach to an intermediate air chamber are avoided. Why errors of so grave a character as he found are caused by an intermediate air chamber, the Author, even now, is unable to say; but it was in consequence of such errors, that in the year 1861, after a week's unprofitable labour with a King's transferrer, he was led not only to cast the latter aside, but from pressing necessity to devise a method whereby to apply the bottle as a direct measure.

43. The frontispiece shows the manner in which Hartley's

* Other methods of using a cubic foot bottle are described in the latter part of the book.

transferrer is connected to a perfectly adjusted "Inspection-Standard" gasholder, for the purpose of graduating the bell into divisions each equal in capacity to 1 cubic foot. The connection between the two instruments is made by a short piece of the best india-rubber tube, and the governor G of the transferrer is shut off from the circuit. The water in the gasholder tank, in the tank T of the transferrer, and the air in the testing room, must be of the same temperature, and should be as nearly at 62° Faht. as is possible, although the Author has found, in his very extensive experience in the graduation of gasholders, that no sensible difference in capacity exists between gasholders graduated with the water and air at 45° and at 65° Faht., but it is of the utmost importance that the temperature of the water and the surrounding air be the same. How important will be readily understood when it is remembered that air changes in volume about one per cent. for 4° Faht. at ordinary temperatures. Hence, if the air were higher than the water by such a difference during the testing of a holder, errors far greater than are permitted would be produced on the scale. The first operation is to test the soundness of the bell and connections. To do this, the bell of the gasholder is raised to its highest elevation, as is also the tank T of the transferrer. All the weights M are then removed from the gasholder so as to cause it to give 3 inches pressure. A mark is then made on one or both scales of the gasholder bell, and all is left at rest for at least half-an-hour. If the bell has remained stationary, testing may be commenced. The tank T is lowered, the bell R nearly emptied of air, the weights M replaced, and marks made on the front and back scale directly opposite the pointers which are fixed on the top of the tank. T is again raised to the needful height, and a cubic foot of air is thereby driven into the holder. The delivery stop-cock of the transferrer is closed, and the air-cock is opened to the bottle. While one of the operators marks

the scales of the holder, the other lowers T, and thereby re-charges the bottle of the transferrer with air, and then closes the air-cock. Successive deliveries are in this way made into the holder with considerable rapidity, for the Author compensates for water adherent to the interior of the bottle, which, however, is very small in quantity, and if neglected would only induce an error of about 1-3000th part in a cubic foot. Each cubic foot division thus measured on the scales is divided into 10 parts, and sub-divided into 100 parts when engraved.

44. In the verification of an "Inspection Standard" at Governmental departments, the cubic foot bottle is not employed, but the gasholder to be verified is connected to the Government Standard gasholder, and air is passed several times from one to the other in succession. The respective scale indications being observed when both gasholders are balanced, *i.e.*, giving no downward pressure. Equality in temperature is strictly regarded in relation to both air and water. And at the Standards Department of the Board of Trade in this country, such verifications are carried out at the temperature of 62° Faht. as nearly as possible.

ON THE KINDS OF METERS TO BE TESTED, &c.

45. By the 12th Clause of the "Sales of Gas Act," it is enacted that:—

"No meter shall be stamped which shall be found by the inspector to register, or be capable of being made by any contrivance for that purpose, to register, or by increase or by decrease of the water in such meter, or by any other means practically prevented in good meters, to register quantities varying from the true standard measure of gas more than two *per centum* in favour of the seller, or three *per centum* in favour

of the consumer; and every meter, whether stamped or unstamped, which shall be found by such inspector to register, or be so capable of being made to register, quantities varying beyond the limits aforesaid, shall be deemed incorrect within the meaning of this Act; and every meter which shall be found by any such inspector to measure and register quantities accurately, or not varying beyond the limits aforesaid, and shall be found incapable by any such means as aforesaid of being made to register quantities varying beyond the limits aforesaid, shall be considered to be correct, and be stamped as aforesaid in such manner and on such part of the meter as shall be specially directed by the authority appointing him, or in default of such direction as shall, in his opinion, best prevent fraud. Provided always, that every meter having a measuring capacity at one revolution or complete action of the meter of not less than five cubic feet, and having permanently marked upon it in some conspicuous place, the words 'without float,' shall be stamped by the inspectors, if found correct, within the meaning of this Act, in all other respects except that it is capable of being made by abstraction of water to register incorrectly against the seller of gas, but it shall not be lawful after the time aforesaid to use in the sale of gas any such meter, when so stamped by the inspector, except by written agreement between the buyer and seller, specifying that this description of meter shall be used."

46. It will be seen from the above clause that two classes of wet meters are permitted to be stamped, viz., those which are *incapable*, and those which *are capable* of being made to register more than three per centum against the seller, on condition, in respect of the latter, that such meters shall be of such size as to pass at least five feet per complete action, and be distinctly marked with the words "without float." Many, if not most, of the meters "without float," will be the kind called "station

meters," from the fact of their construction being identical with those used in gas works and stations for measuring the gas manufactured.

47. Meters of the kind just mentioned, as well as all others of five or more cubic feet measuring capacity per revolution, which have *no* float must be inscribed as "without float," and these words are best put on a badge bearing the maker's name, number of the meter, and its capacity per revolution and per hour. The badge should be screwed on to the front of an iron-cased meter, and the inspector's stamp should cover one or more of the screw heads.

48. Every meter submitted for testing to an inspector appointed under the "Sales of Gas Act," must have affixed upon it a badge, specifying "its measuring capacity at one revolution or complete action of the meter, and also the quantity per hour it is intended to measure in cubic feet, or multiples or decimal parts of a cubic foot."

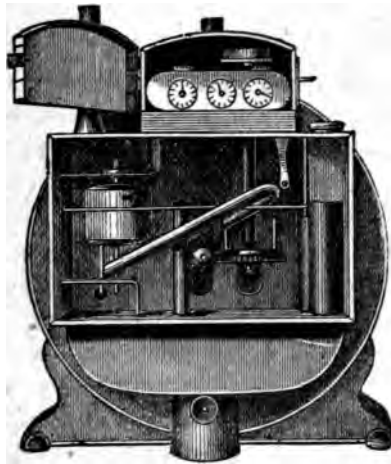


FIG. 10.

49. On every ordinary wet meter there are *two* plugs, *one* on the upper part, called the *charge-plug*, and *one* at the lower part of the case, called the *syphon* or *overflow plug*. Both these plugs are in front of the meter case.

50. In the index of every ordinary wet meter, there is a small metal drum as shown in fig. 10; or, in lieu of the drum, an additional circle on the

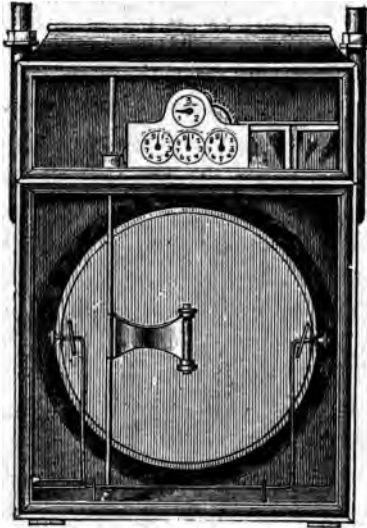


FIG. 11.

index plate, as in the dry meter; fig. 11. This drum or circle is divided into 2, 5, 10 or more principal parts, representing as many cubic feet of measurement by the meter. It is by finding the quantity of gas, measured by the gasholder, which is required to pass through the meter in order to cause the index drum, or the pointer of the circle, to make an entire revolution, that the accuracy or the inaccuracy of the meter is determined.

STATION METERS.

51. Wet meters of the kind designated in the trade as station meters, simply because they are in form and construction similar or identical to those employed in gas works, have also to be tested, and for the larger sizes of these the test gasholder is useless, and the test meter must be used.

52. A station meter may, as to its case, be a simple cast iron cylinder, or a segmental cylinder (fig. 12), or a rectangular plain or ornamental cast iron tank (fig. 13), and the measuring capacity of its wheel may range from 5 feet per revolution up to 1000, or even 2000 cubic feet.

53. With all station meters, the *index* is placed in the centre of the front, and the gas-inlet is in the centre of the back, the gas-outlet is also at the back and on one side of the inlet. Both the inlet and outlet openings are fitted with flanges for the

FIG. 12.

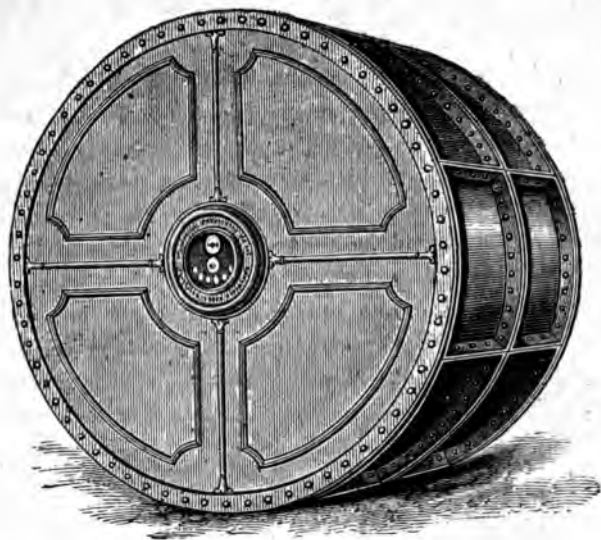
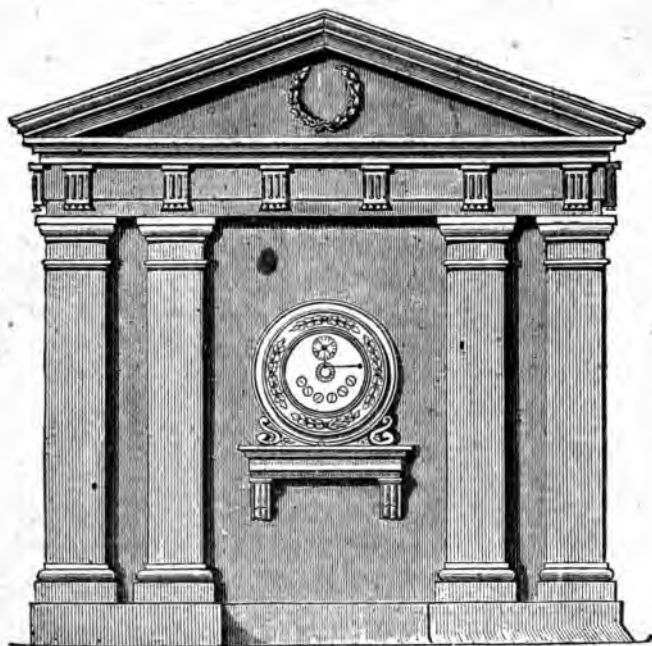


FIG. 13.



attachment of the main pipes. The water-level of the meter is indicated on a gauge, similar to a boiler-gauge, affixed to the meter case, the glass tube of the gauge being protected by a sheath or other contrivance bearing the maker's number of the meter and the water level mark or indicator. This sheath or contrivance should be stamped by the Inspector when such

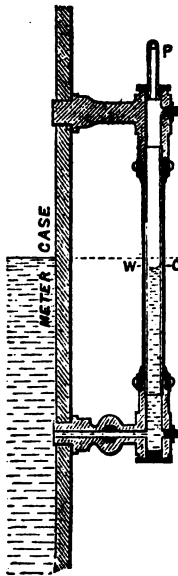


FIG. 14.

a meter is tested. Sometimes this gauge is so affixed to the meter as to be acted upon by the outlet pressure, it then shows the dead level of the water, i.e., the level when the meter is not working, but it is better to connect the gauge to the inlet, so that it is acted on by the inlet pressure of the gas as in fig. 14, where the pipe P is supposed to connect the gauge with the inlet, for a consideration of the conditions under which a meter measures gas (35 to 38), shows clearly that *all meters to which gauges are affixed to indicate the water-level should have the water-line defined while the meter is in motion.* The advantages are, that an Inspector may test a wet meter at any convenient or possible rate of speed, marking the "working line" while it was in action, disconnect his testing apparatus, set the tested meter in full action,

and then add the needful quantity of water to make it measure correctly. Further, an inspection of the water-line when the meter is in full action will at once show whether it is properly charged. The increased accuracy of registration on this system would, in many instances, amount possibly to 2 per cent. On the usual system the gas must be *shut off* from the meter before the water-level can be adjusted, causing at times much trouble and inconvenience.

54. Some meters are provided with a gauge similar-in construction to that shown in fig. 15. As shown it is a box, rectangular in shape, attached to the meter case, and in communication with the interior thereof at a point *x*, below the water-line of the meter.

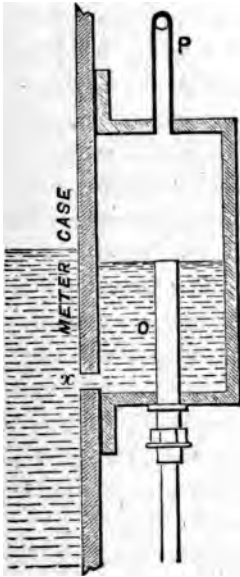


FIG. 15.

P is a pipe connecting the box with the inlet of the meter, so that the inlet pressure of the gas may act within the box. *O* is a vertical pipe screwed through the bottom of the box, and rising therein to the needful height for its top to coincide with the water-level. The bottom of *O* is sealed in a lute from which a pipe extends to a sink or drain. A meter which is provided with such a gauge as this cannot be overcharged with water, for any excess which may be run into the meter at once flows away through *O*. It is usual with large station meters in gas-works to keep a constant stream of

water flowing into the meter, for the purpose of maintaining the water-level within the measuring wheel as equable as possible under varying rates of speed (36), and also for the purpose of keeping the water in the meter in as clean a condition as possible. The box being subject to the inlet pressure, and the top of the pipe *O* coinciding with the line of true measurement within the wheel, it will be apparent that when the working speed of the meter is increased, the incoming water soon restores the true level, and that when the working speed slackens the increased rapidity of the outflow soon disposes of any excess.

55. Another form of water-level gauge is shown in fig. 16. This form was devised by Mr. Mills, Meter Inspector of the Metropolitan Board of Works, at Westminster. It serves simply as a seal box, and is acted on by the outlet gas through the hole G, the water entering the box from the meter through a lower hole. The pipe P is cut to the water-line, and the water flows into C, thence through the channels D, E, into the outer chamber F, and out at the spout. The advantage of this box is that an excess of water cannot be run off, or syphoned out from F, for, although it may be syphoned from E, F, yet, as the water column is broken above E, the channels D C re-

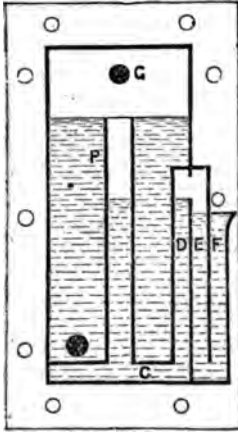


FIG. 16.

main charged, thereby preserving the true level and preventing the escape of gas.

There are several other forms of over-flow water-level gauges, but those which have been described embrace the principles on which all are constructed.

APPARATUS REQUIRED FOR THE VERIFICATION OF GAS METERS.

56. ONE OR MORE INSPECTION STANDARD GASHOLDERS.

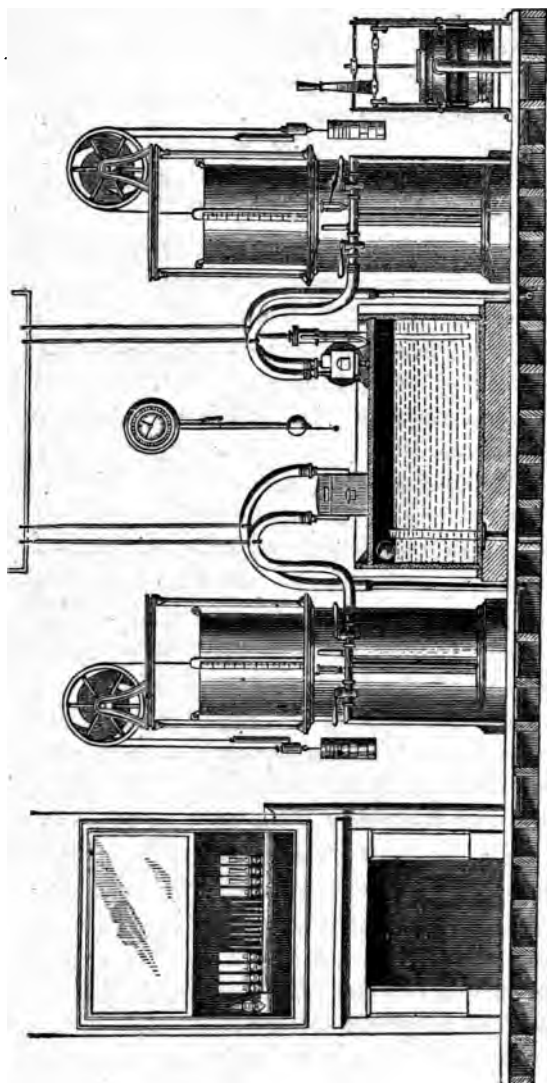
In towns where a large number of meters will require to be tested, *four* or even *six* gasholders may be needed, but in most cases *two* will be sufficient, and the *most useful* are those of *ten* cubic feet nominal capacity. In some cases a five-foot holder is used for testing for soundness, and a ten-foot holder for the test for registration. *One-foot* holders are *useless* for meter testing.

TWO LENGTHS OF FLEXIBLE TUBE FOR EACH HOLDER.

These are fitted to meters with screwed brass sockets to receive cones of the several sizes required to fit the unions of gas meters. One of these tubes is attached to the outlet of the gasholder, and the other to the pipe which conducts gas from the meter under testing.

A PROVING-BENCH.

This may be a strong table of wood with a lead covered, or a slate top, which must be perfectly level, or it may be a cistern about 5 ft. 6 ins. to 6 ft. long, 2 ft. 6 ins. wide, and 2 ft. 6 ins. deep; its elevation to the needful height being effected by placing it upon blocks or brickwork, leaving a part of the space below open from back to front. The edge of the *front* plate of the cistern should be *one inch above*, and the edge of the *back* and *end* plates *three inches above* the level of the top slab. The top slab should be 1 in. or $1\frac{1}{4}$ in. thick, the edges, in the direction of its length, should be rebated, and the upper surface be planed perfectly flat. The width of the top should be 3 ins. less than the internal width of the cistern, and it should be so adjusted as to leave an opening along the back of the cistern 2 ins. wide, and an opening the front of the cistern 1 in. in width. These openings should be covered with strips of perforated zinc, fitting upon the rebates of the top and into saw-cuts in the back and front plates. The gratings, thus formed, permit the free flow of water into the cistern when wet meters are being emptied, after having been tested. The raised edges round the top of the cistern prevent the slopping over of water. The cistern should be fitted with *water-supply pipe and ball-cock*, and with an *overflow or waste-pipe*. As the water has to be drawn from the cistern for the purpose of charging wet meters, a *small*



GAS METER TESTING APPARATUS.

pump is also required, which may be fixed on the cistern as shown, or be placed in any other situation which may be more convenient.

ONE OR MORE FLOATS.

Each float consists of a length of 2-inch iron tube, mounted along its length by 20 brass cocks, each supporting a burner. The 2-inch tube terminates with an $1\frac{1}{4}$ blow-off cock.

TWO OR MORE GAS TORCHES,

each with 10 feet of flexible tube.

A CLOCK,

indicating seconds, minutes, and hours, striking at the end of each minute (when required to do so), and going eight days.

A PAIR OF DOUBLE BLAST BELLOWS.

These are only required when air is used for testing meters instead of gas.

THERMOMETERS.

For taking the temperature of air and of water.

57. A convenient arrangement for two gasholders is shown in the illustration. The proving-bench stands between two gasholders, one of which is for use with gas, while the other on the right, is for use with air, its inlet being connected to a pair of double-blast bellows. From the outlets of the holders, the *flexible tubes* are extended and terminate in the *brass sockets*, into which the *cones*, of the size requisite to fit into the unions of the meters about to be tested, are screwed. These tubes and cones serve to connect the gasholders to the inlets of meters. Similar connections are needed for the outlets of meters, and are shown on the pipes which descend to the floor, and on the gas side are continued to the *float of lights* enclosed in the chimney breast. On the air side the pipes should be extended to some convenient point of dis

charge beyond the room, in order to prevent smell and the possibility of the explosion of the mixture of gas in a meter, which has been tested for soundness, with the air from the holder. Immediately beyond the point of its junction with the flexible tube, the pipe which carries off the air or gas from the outlets of meters should be fitted with a *thermometer*, and if *air* be used for testing, it should be also fitted with a 2-inch cock. The use of these, as well as of the cock on the end of the float, will be explained further on. It will suffice to say here that the last-mentioned main-cock should be fitted with a piece of $1\frac{1}{4}$ iron piping projecting into the chimney, in order to carry off unconsumed gas. The float of lights is enclosed in a frame of wood or iron, the upper half closed in, while the lower part is provided with a sliding glazed shutter, which is to be drawn down when many lights are burning. The bottom part of the frame is left wholly or partly open for the passage of air to the flames, and at the top inside, an opening made into the chimney. In some cases the burners may be fitted in the space usually occupied by the stove. If there be no chimney available, and the room be open in the roof and well ventilated, the float may be fixed at any point in the room, at a height of at least two feet above the tops of, and as *far removed* as possible from, the holders.

58. The clock shown is of the description called a *minute clock*. It is constructed to strike every minute, when it is required to do so, and is extremely useful in the adjustment of the gas, passing through meters, to the required rates per hour (67).

59. A *torch burner* for applying a flame round the meters and connections during the gas test is necessary, and another is required for the float of lights. Each consists of a small burner fitted on a short handle, and supplied with gas through a flexible tube.

60. The advantages of the proposed arrangement are:—The apparatus is brought into close and convenient proximity—the water used for wet meters, by being kept in the cistern, is maintained as nearly as possible at the same temperature as that in the gasholder tanks, and by repeated use becomes charged with gas and with its condensible constituents*—the heated products from the gas consumed in the float of lights are prevented from seriously affecting the temperature of the room, while the use of two gasholders at one bench facilitates the inspector's operations, as he can readily conduct the tests for soundness and for registration at the same time.

61. As meters of too large a size to be placed on the proving-bench have sometimes to be tested, it is advisable to provide a *level slab* or *grating* in front of the proving-bench for such meters to stand upon, and when the meter evidently requires for its verification the delivery through it of more than 10 cubic feet of air or gas, its inlet should be connected to the outlets of both holders by means of a coupler, so that the holders may be successively discharged, and as, in some cases, the contents of even two holders will be insufficient, it is advisable also to arrange their inlet pipes so that both can be expeditiously filled either with air or with gas. If these arrangements be made, the holders can be alternately filled and discharged, and a continuous delivery of air or gas through the meter be maintained for any length of time.

* "Water is never met with naturally in a state of purity. Rain water, "collected after a long continuance of wet weather, approaches nearest to "it, but even this always contains atmospheric air to the extent of about "2½ volumes of air in 100 of water" (Milner's Inorganic Chemistry, p. 41). Water possesses a like power of absorption on all gases, but in varying degree. Clean water induces also a partial condensation of the hydro-carbon compounds of coal gas, hence the water used to charge wet meters, in testing operations, should be as nearly as possible saturated with gas and its condensible constituents. If clean water be used the gas should be allowed to flow through the meter for a little time before the test is made, and the purer the water the greater the necessity, as a rule, there is for this practice.

62. In the Engraving and foregoing remarks, one holder is represented for use with air. The Author considers, however, that it is best to use gas for all the testing operations, and for the following reasons:—first, it is difficult to ascertain with air whether the joints of the connections are sound, which can easily be determined by the application of a flame when gas is used; secondly, it is far more difficult to register wet meters at the low-water level with air than it is with gas. If air be used the bellows are not indispensable, but without them the time and labour in filling are at least quadrupled.

I N S T R U C T I O N S

FOR FITTING UP AND ADJUSTING

I N S P E C T I O N - S T A N D A R D G A S H O L D E R S .



63. (a). Place the tank in the position which it is to occupy on a solid, firm, and level base.

(b). Place the graduated bell within the tank, with the side which carries the brass number badge to the front of the tank. Take care in putting the bell into the tank that the bottom guide rollers fit the guides which extend from the top to the bottom of the tank.

(c). Place the two pillars in their respective positions (indicated by corresponding numbers or marks) on the top of the tank, and secure them loosely, but safely, to the tank by means of the bolts furnished. In setting the pillars up, take care that the top wheels of the bell run easily in or upon the guide grooves or ribs of the pillars.

(d). Place the beam on the tops of the pillars and secure it, but not too tightly, to the pillars by means of the screws provided. No mistake can be made as the screw holes

are differently placed at the two ends and on the tops of the pillars.*

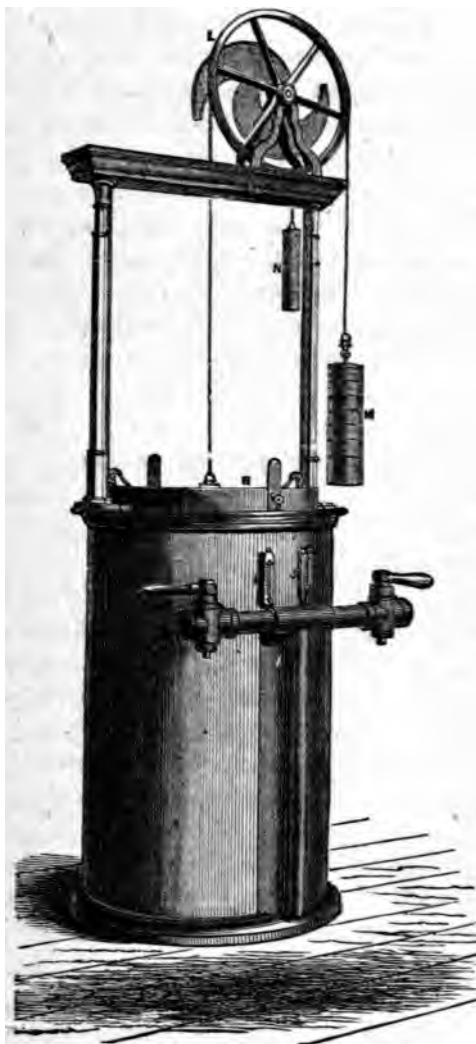


FIG. 18.

(e). Note (by means of the screw holes in the beam seatings and in the flanges of the wheel standards) which standard is to be placed on the front side of the beam. Into the bearing of this front standard insert the short journal of the spindle of the wheel L, the longer journal will rest in the bearing of the back stan-

* When two gasholders are supplied for use in the same testing room, they are made right and left handed in respect to the position of the weights in order that they may stand conveniently, as shown in the illustration of testing apparatus, at the ends of the same proving-bench; when, however, a single gasholder is to be employed, it is usually made right handed, unless specially required otherwise.

dard. Fix the standards and wheel above the beam by means of the screws provided.*

(f). Attach the wire cord by means of its nut to the bell, pass the cord over the wheel L, and suspend the back weight only by means of its hook to the eye on the free end of the cord.

(j). Place the compensating curve on the square end of the wheel spindle, and secure with the nut. Attach the compensating weight (N) to the nut at the end of the cord, and pass the latter into the groove, so that the weight hangs freely from the curve. With the bell resting on the bottom of the tank, turn the wheel L until the cord cuts, or crosses the centres of the two holes which are stamped in the plate of the compensating curve.

(k). Place the loose weights, viz.,

Five, *five-tenths* of an inch pressure weights

Two, *two-tenths* " " "

One, *one-tenth* " " "

upon the back weight, as at M.

(l). Next, carefully observe whether the cord by which the weights are suspended hangs parallel with the pillars when regarded both from the side and front of the gasholder. If it does not, the gasholder must be re-adjusted until the cord does hang in the manner indicated, or, at all events, very nearly so.

(m). Now charge the tank with water up to the height indicated by the water-line cock, which is a few inches below the top of the tank.

(n). At this stage it is advisable to try the working of the instrument. To do this, place a two pound weight on M (if it be a 5 or 10 cubic foot gasholder), when, the cocks being open,

* If the V shaped grove of the wheel be at all greasy, the grease must be completely removed, and the V surface dusted with emery or similar powder, otherwise there will be danger of wheel slipping when the compensating weight N is attached, and the bell be raised to its full elevation.

the bell should rise easily to its full elevation. Supposing this to be the case, remove the two pound weight from M and place it on the top of the bell as near to the centre as possible, and the bell should descend with freedom. If there should be any excess of friction, the bell may cease to move, or move very sluggishly. In such case adjust the pillars, the wheel standards, &c. (all of which can be sufficiently shifted to ensure freedom in the motion of the bell), and oil the several bearings. Finally, fix the screws and bolts of the various parts. If excessive friction be still manifested, examine the bottom rollers of the bell and the guides in the tank in order to see if they have been injured. There ought to be no difficulty in adjusting the instruments to work easily under an operating weight of two pounds. *Every Gasholder made by A. Wright & Co. is proved to be effective under such operating weight and even at times under a lesser weight.*

(o). Fix the thermometer I and pressure gauge J (the latter charged with water to the zero line) in their places on the stand-pipe. Put the plugs which carry the pointers into the sockets on the edge of the tank. The pointers should be about $1\frac{1}{4}$ inch above the level of the tank, and to bring the 11 cubic-foot line of the scales level with the pointers, the bell must be slightly raised. Raise the bell until the 11th or top line is cut by, or coincides with the pointer of the front. Adjust the back pointer if needful till it coincides also with the 11th cubic-foot line of its scale. Close the cocks, and again place a two pound weight on M, then partly open one of the cocks and allow the bell to rise until the 10th cubic-foot line is opposite the front pointer, instantly close the cock, and see that the pointer at the back is also opposite the 10th cubic-foot line of scale. Proceed in this way with every numbered line to zero, then remove the pound weight and also a *two-tenth* weight from M, and repeat the operation with the bell descending. The scales have been

in absolute agreement when graduated, and should, when the holder is refitted, agree to within less than *one-hundredth* of a cubic-foot division in rising, but in descending there may be a little greater discrepancy owing to the swing or play which must be allowed to ensure freedom from friction. If the scales disagree to any considerable extent with a rising bell, the level of the tank must be readjusted so as to bring the scales into closer agreement. It may be remarked, however, that readings are seldom taken from the back scale, as the measurement by one scale is sufficiently accurate.

(p). Finally raise the bell to its full height, close both cocks, remove all the *loose* weights M, leaving only the back weight hanging to the cord, and let the bell descend until the zero line of the observed scale is opposite the pointer. If any leak exists, examine and make sound the junctions of the thermometer, of the pressure gauge, the left hand top screw of the latter, and of the cock at the bottom of the front stand-pipe. When apparently quite sound, let the bell remain up subject to 3 inches pressure for at least half-an-hour. The cock at the bottom of the stand-pipe closes an opening by which any water accidentally driven into the stand-pipe may be allowed to escape.

(q). After the gasholder has been put into use, it should be examined at least weekly,—

- 1st. In respect to height of water in the tank.
- 2nd. Soundness.
- 3rd. Position of compensating cord in relation to gauge holes in the plate of the compensating curve.

TESTING OPERATIONS.

64. Before a *wet meter* can be tested, it must be properly charged with water. The manner of effecting this is as follows:—
Remove the corks or stoppers which are usually placed in the

inlet and outlet unions by the maker, or, *better*, take off the caps and linings. Set the meter, if of moderate size, on the proving-bench—or, if it be a large one, on the ground or floor—taking care that it stands perfectly level. Remove from ordinary meters the two plugs mentioned in a preceding paragraph (48), and pour water through the socket from which the charge-plug is removed until a free flow ensues from the meter at the syphon socket. This is the only way by which a proper charge of water can be insured with many “consumer’s” wet meters. Leave the meter undisturbed till dripping of water has ceased, replace the plugs, and the meter is ready for testing.

65. *Dry meters* require no other preparation for testing than the removal of the stoppers, or, of the caps and linings, and the placing level on the bench.

66. Cones of suitable size to fit into the unions of the meters to be tested are to be screwed into the sockets on the ends of the flexible tubes of gasholders (57). The cones on the *gasholder pipes* are to be inserted into the *inlets*, and the cones on the *other pipes* into the *outlets* of the meters. The junctions must then be made sound with a little putty pressed round the cones and upon the tops of the unions.

67. By Clause 13 of the “Sales of Gas Act,” it is enacted that:—

“The following rules shall be observed by the inspectors in testing meters under the provisions of this Act:—

“Firstly, the meter shall be tested for soundness and leakage only, and not for per-centage of error, when fixed on a horizontal base, and with the gas under a pressure equal to a column of water three inches high, with a light or lights consuming not more than one-twentieth part of its measuring capacity *per* hour marked thereon, nor less than one-half of a cubic foot *per* hour, for all meters of a measuring capacity not exceeding one hundred

cubic feet *per* hour, and not more than one-fortieth part of its said measuring capacity *per* hour, for all meters of any greater measuring capacity *per* hour than one hundred cubic feet; and all meters found to work under such test shall be deemed sound meters, and any meter found not to work under such test shall not be stamped.

“The meter to be tested for per-centage of error shall be fixed on a horizontal base, and shall be tested at a pressure equal to a column of water five-tenths of an inch high, and passing the quantity of gas or atmospheric air *per* hour which shall be marked thereon as its measuring capacity *per* hour, and the water used in such testing, and the air of the room in which such testing shall be made, shall be as nearly as practicable of the same temperature as the gas or air passed through the meter.”

68. DRY METERS.—With these the testing operations are two in number, viz. :—

Test for soundness.

Test for per-centage, FAST OR SLOW.

69. WET METERS.—With these the operations are three in number, viz. :—

Test for soundness.

Test for per-centage, FAST.

Test for per-centage, SLOW.

70. The gasholder having been filled with gas from the service pipe connected with one of the cocks of the holder, the meter placed on the proving-bench, charged with water, and the plugs replaced if the meter be a wet one, and its inlet and outlet connected with the proper pipes, in accordance with preceding paragraphs, the mode of performing the testing operations may now be illustrated.

71. TEST FOR SOUNDNESS.—The Act prescribes that the rates

at which gas shall be passed through meters under this test, shall be as follow:—

1	Meters of a capacity to pass 10 cubic feet or less per hour.	Under this test are to pass	Half-a-cubic foot per hour.	
2	Meters of a capacity to pass from 10 to 100 feet per hour.	Under this test are to pass	1-20th	Of their measuring capacity per hour.
3	Meters of a capacity to pass more than 100 feet per hour.	Under this test are to pass	1-40th	

Half a cubic foot per hour is 83-thousandths of a cubic foot per minute. In practical work this may be taken as *one* one-hundredth of a cubic foot per minute, and for meters of the larger sizes, the following rates per minute may be adopted as quite near enough:—

CLASS 2.

Capacity cubic feet per hour	12½	15	20	30	40	50	60	80	100
Rates per minute in 100ths of a cubic foot .	1	1	2	3	3	4	5	7	8

CLASS 3.

Capacity cubic feet per hour	120	130	150	200	250	300	350	400
Rates in 100ths of a cubic foot per minute . . .	5	6	6	8	10	12	15	17

72. With, say half-inch pressure on the gasholder, pass sufficient gas through the meter to expel the air. When this is

done, shut off the gas and remove all the loose weights of the gasholder in order to obtain three inches pressure. Close all the cocks on the float of lights, and turn on the gas to the meter. Then open one or as many burners as may be necessary, and regulate by their cocks until gas is passing through the meter as nearly as possible at the rate prescribed by the Act. Next, pass the flame of a gas-torch round the meter and connections. Should a leak exist in any part of the case, the meter must be rejected as *unsound*, as it must also be if the index fails to record the passage of gas. In this test it is sufficient to determine that the index *moves*, and in something like apparent agreement of registration with the gasholder.

73. To save time with small meters it is a good plan to have a few platinum or steatite jets with orifices of such size as to allow about half-a-cubic foot of gas to pass per hour under a three-inch pressure. These burners if mounted on short stems or pillars provided with cocks, can be affixed to the outlets of the meters, and the adjustment to the required rate per hour quickly made. The gas passing from larger meters, must be consumed at the float, as the heat given out would affect the temperature near the holders.

74. EXCESS OR FAST TEST.—Having determined the soundness of the meter, turn off the gas, and, if the same holder be used, replace as many of the weights as will reduce the pressure to half-an-inch. If the meter be a wet one, remove the outlet connection of meter, and take out the charge and syphon plugs; if any water flow out, add more, and allow the excess to drain off. Replace the outlet connection and open some of the burners (57); turn on the gas and adjust the cocks until the meter is working at its proper rate per hour.* Observe the index drum

* The regulation of speed must in all cases be made by adjustment of the cocks *beyond the outlet* of the meter, and not by the gasholder cock. It is for the purpose of adjustment of speed that the cock is placed on the air *outlet* there being no float of lights on the air side.

(50), and as soon as a figured division is brought directly under the pointer, turn off the gas. Re-fill the holder to the zero point, and then pass gas through the meter until the index drum has made an entire revolution and the division started from is again brought under the pointer, shut off the gas, and read on the gasholder scale how much gas has been used. As, in almost every case, a quantity more or less than an exact number of cubic feet will be used from the holder, while the meter will always record an exact number of cubic feet, it follows that the per-centage of error can only be arrived at by a proportion.*

75. Thus, if the gasholder reading be 99 cubic feet, and the meter record 100, the per-centage of error will be 1·01 per cent. fast—

$$99 : 100 :: 1 : 1\cdot01.$$

If the registration of the meter does not exceed 2 per centum fast, or in favour of the seller, it is correct within the meaning of the Act, and if it be a dry meter must be stamped, but if it be a wet meter it must then be submitted to another test.

76. DEFICIT OR SLOW TEST.—With the gasholder still in communication with the inlet of the meter, and the outlet of the latter delivering gas to one or more burners, draw off sufficient water by means of a syphon dipping into the meter, through its charge ring, in order to bring the float down, and thereby close the inlet valve. The instant this is effected the gas will cease to pass to the burners, and the flames will be extinguished. Sometimes it may be most convenient to tilt the meter, and so draw off water from the lower socket. If this be done, the meter must be restored to a horizontal position, and a gas-torch flame applied to the burner or burners in order to make sure

* To save trouble in making calculations, a Table, extracted from a more extended one, compiled and printed by the authority of the Board of Works for the use of their inspectors, showing the per-centages on various quantities, is given at the end of the book.

that no gas is passing. Next, with gas still turned on, pour water very gently into the meter, tapping the meter with the finger the while, until the float rises and allows gas to pass freely. Care must be taken not to add more water than is absolutely necessary to lift the float, and it is to assist the rising of the latter that the tapping is recommended. While performing this operation, a small flame should be applied to the float burners, so that the instant the gas passes it may become apparent from its ignition.

77. Now take starting points on the index drum (50) and on the gasholder scale, as in the former test, and register. If the meter be not more than 3 per cent. slow, it will be correct within the meaning of the Act, and must be stamped.

78. When testing large meters, do not attempt to burn all the gas, as great heat would be given out, but open, or partly open, the large cock on the float of lights, so as to permit a portion to escape unconsumed into the chimney.

79. In the foregoing, the process of testing with *gas* has been explained. Air can, however, be used without difficulty in the test for per-centage of error *fast*, but not so easily in the test per-centage of error *slow*, except when the measuring wheel is visible through the outlet of the meter. In such cases proceed as follows:—After drawing off water, remove the outlet connection from the meter, and *nearly cover* the outlet union with a small piece of glass. Turn on the air, pour in water, and gently tap, as before directed; while doing so look through the glass down upon the measuring wheel, and, as soon as this is observed to move, cease to add water; replace outlet connections, and proceed to register as with gas (104).

CORRECTIONS FOR TEMPERATURE.

80. There is both trouble and uncertainty in the making of corrections, when gas or air changes its temperature in its passage from the holder through a meter, and it is advisable to use every possible care to maintain the testing room, the water in the gasholder tanks, and the water with which wet meters are charged, at the same temperature. Such care will demand less trouble, while it will ensure greater accuracy than is possible with calculated corrections.

81. It is usual to assume that the temperature of the gas or air at the outlet of the meter represents the temperature at which the gas or air has exerted its effect in working the meter. It has been suggested that it is doubtful whether this is the case, inasmuch as such assumption is based on the idea that the change in temperature is instantaneous. The experiments of the Author tend to prove that the change is really so promptly effected that the outlet temperature may be fairly taken to represent the temperature within the meter.

82. It will be realized, however, that the conditions under which the testing of ordinary gas meters are conducted are such as to render scientific accuracy impossible. It is inconvenient to attach a thermometer immediately to the outlet of each meter, and if this were done, the rough work of a testing-room would scarcely permit of the use of thermometers of a sufficiently sensitive and therefore delicate character; but still as much care as possible should be taken to ascertain the temperature of the gas or air employed as it leaves the gasholder, and as it afterwards leaves the meter. In most cases, the nearest approach to the proper application of a thermometer which can be made is by the insertion of one of a moderately sensitive kind in the iron pipe which conducts the gas to the float of burners, and at a point very near its junction with the flexible tube.

83. The following table by the Astronomer Royal was published in a Parliamentary Paper, No. 339, Session 1861, and shows the per-centage increase or dilatation of the volume of gas above its volume at $31\cdot4^{\circ}$ Faht. when in contact with water, and saturated with aqueous vapour for given temperatures, and its examination will show that between $44\cdot17^{\circ}$ and $67\cdot43^{\circ}$, the difference in volume approximates closely to one per cent. for every four degrees difference in temperature :—

Temperature in Fahrenheit's Scale.	Per-centage of Dilatation.	Temperature in Fahrenheit's Scale.	Per-centage of Dilatation.	Temperature in Fahrenheit's Scale.	Per-centage of Dilatation.
31·40	0	54·33	5½	74·30	11
33·54	½	56·24	6	75·94	11½
35·70	1	58·12	6½	77·23	12
37·84	1½	60·02	7	78·81	12½
39·91	2	62·00	7½	80·40	13
42·05	2½	63·77	8	81·94	13½
44·17	3	65·63	8½	83·44	14
46·22	3½	67·43	9	84·88	14½
48·25	4	69·18	9½	86·39	15
50·32	4½	70·90	10	87·83	15½
52·36	5	72·60	10½	89·20	16

84. Hence for ordinary purposes, and for ordinary temperatures, corrections may be made on the basis that—

Four degrees Faht. increase or decrease in the temperature of air or gas over water produce one per cent. difference in the volume of such air or gas.

85. With gas issuing from a meter at a different temperature than it issues from the test gasholder.

RULE :—Multiply the number of cubic feet and parts delivered from the holder by the number of degrees of difference in temperature, and by ·0025, and (a) if the gas issuing from the meter be *highest* in temperature, add the product to the quantity indicated by the gasholder; (b) if the gas

be of lower temperature at the outlet of the meter, *subtract* the product from the gasholder reading. Ex. :—

Temperature at holder	(a) 59°	(b) 61°
Temperature at meter	61°	59°
Difference at meter	2° higher	2° lower
Meter registration	5 c. ft.	5 c. ft.
Gasholder indication	4·9 c. ft.	4·9 c. ft.
4·9 × 2 × ·0025	·025 = nearly = ·025	
Volume passed through meter...	4·925 c.ft	4·875 c.ft.
The nearest numbers in the table are	4·93 c. ft.	4·88 c. ft.
The meter would appear as ...	1·42 fast	2·46 fast
But for gasholder indication, would appear as	2·04 „	2·04 fast

86. A simpler, but less accurate, method of correcting for temperature, is as follows:—

RULE.—With gas issuing from the meter at a *higher* temperature than from the holder, *subtract* the per-centage difference in volume from the per-centage of error as per Table, and when the gas issues from the meter at a *lower* temperature, *add* the per-centage difference to the per-centage error of the Table. Ex. :—

Ex. Gasholder reading . . .	4·9 c. ft. . .	4·9
Temperature at holder . . .	59° . . .	61°
„ „ meter . . .	61° . . .	59°
Differences = half per cent.		

Per cent. error by table . . .	2.04 fast . . .	2.04 fast.
Subtract . . .	.5	Add 5
	1.54 fast	2.54 fast
Error by previous rule . . .	1.42	2.46
Differences per cent. by second rule	0.12	0.08

87. The illustrations which have been given show the importance of due regard to the maintenance of equality in temperatures in meter testing, or for *somewhat* careful observations as regards differences. Sufficient care, up to the present time, has certainly not been generally exercised, and many a correct meter has, from this cause, been made to appear inaccurate. The Author has had many meters which had been tested by other persons, and pronounced by them to be in error, but which careful testing under his hands proved to be absolutely correct.

THE TEST-METER.

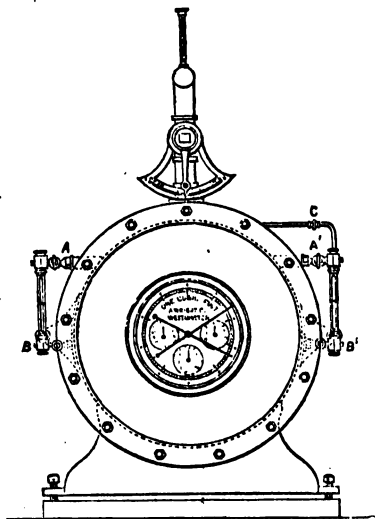


FIG. 19.

88. Place the test-meter on a tolerably level and firm stand or board, as in fig. 20, as near to the meter to be tested as may be convenient. Open the cocks, A, A', B, B', of all the gauges. Insert a funnel into the charge-socket on the top of the test-meter, and if the meter has three gauges pour in water until it reaches very nearly to the marked water-lines, then by means of the screws in the feet adjust to a perfect level and add more water until in *each* gauge the lowest part

of the meniscus or cup formed by the water coincides with the water indicator. If the meter is fitted with spirit levels (26) and has only one gauge it may be levelled first and then be charged with water, but the spirit levels should be examined after so charging with water and a readjustment made if necessary; should too much water have been put in, the excess must be drawn out through the cock in the lower part of the meter case. Insert the thermometer in its socket (25), and the meter is ready for use.

89. If the meter is to be used *at or below* its nominal rate of working (120 cubic feet per hour, or 2 cubic feet per minute for a 20-light, and 600 cubic feet per hour, or 10 cubic feet per minute for a 100-light), the cocks A, A', B, B', of all the gauges must be open, and the cock C, on the tube connecting the back gauge to the inlet, must be closed,* but if the meter is to be worked *faster* than its normal speed, close the cock A' of the back gauge and open C, and while the meter is working at the speed desired (38), add more water until the level in the *back gauge* coincides with the "working level." This addition of water can easily be made through a seal or syphon-funnel, *screwed* into the charge socket of the meter; or, better, the meter may be made with an elbow joint near its base to receive an upright pipe with a funnel on the top, after the manner which is usual with station meters. (W fig. 20).

90. A little practice is needful to make an adjustment of the level while the meter is working, owing to the oscillation of the water, but there is no practical difficulty, and a 100-light may be so adjusted in a very few minutes. The true line is fixed upon by observing that the range of oscillation is equal on each side, that is, above and below the working line.

* Take great care *not* to have A' and C of the back gauge open together or gas will pass from the inlet into the case, and thence unmeasured *from* the outlet of the meter.

91. As a rule, it will be found most convenient to adjust the water-level when the meter is not in action, and then to work it near to its normal speed. As is shown in paragraph 32, *et seq.*, a considerable variation in the rate of speed is needful to induce an error of one per cent. Some experiments with a 20-light test-meter, showed that when it was worked at half speed (60 feet per hour) it registered $\frac{1}{4}$ th per cent. *more*, and when worked at double speed (240 feet per hour) one-fifth per cent. *less*, gas than it delivered. The difference in a 100-light would no doubt be nearly or quite *half* per cent. each way.

TESTING OPERATIONS.

92. There are three conditions under which a meter may be presented for verification by the aid of a test-meter.

1. Fixed in position for use, complete with service pipes, but having no gas delivered into it.
2. Fixed and in actual use.
3. Unfixed and standing in a yard or shop.

93. Dealing with the first condition, and assuming that it is a station-meter which is to be tested, the following description of the diagram, fig. 20, and the accompanying remarks will render the arrangement intelligible. A represents the back of the *test-meter*, B the back of the *station-meter* to be tested, C is the inlet pipe of the later with a valve at D. The outlet pipe is E, having a valve at F, while G is another valve to serve as a by-pass. All these valves are supposed to be, and must be, *closed* when the test is made. H is a pipe connecting the *inlet* pipe, *below* the valve D, to the *inlet* of the test-meter, but the gas may, of course, be obtained from any other convenient source of supply. K is a pipe connecting the *outlet* of the test-meter to the *inlet* of the station-meter at a point *above* the valve D. The pipes H, K, may be of metal or vulcanized rubber, the latter.

kind of tube, if of the best quality, is quite reliable, and is the most convenient to apply in the majority of cases. L is a pipe, provided with a main cock, extending to any safe point for the discharge of the gas. If the meter be in the open air the pipe is not needed, but the cock may be screwed into the upper part of E. M is an overflow water-box, similar to that shown in fig. 15, while P is a pressure gauge on the pipe connecting M to the inlet of the meter. N is a water-level gauge, similar to that represented in fig. 14, but subject, as is also the attached gauge P, to the pressure of the outlet gas. T T are thermometers inserted in the respective outlets of the two meters. W is a pipe through which water is delivered into the station-meter at a point near to its base, while Y is a main cock by which the water may be wholly discharged from the meter when needful. The station-meter may be charged with water to the heights indicated on the gauges through the pipe W, or from a water service-pipe attached to the cock Y, or in any other convenient way; it must, however, be observed that while being so charged, the meter must be in communication with the atmosphere, through L, or some other point. The Author is of opinion that every station-meter should be verified by an experimental determination of the capacity of its measuring drum (see note to par. 98). Hence, whenever it is possible, his practice is to remove the index, and to attach a stout wire, by a screw or by soldering, to the key-wheel (which in nearly all station-meters is in the centre of the index pot), so that the free end of the wire projects a little beyond the edge of the index pot. A pencil or fine chalk mark serving as the starting (and stopping) point. The accuracy of the index train may be determined by calculation after counting the number of teeth in each wheel and pinion, and also by a final revolution or two of the drum after the index is refitted.

TEST FOR SOUNDNESS.

94. Pass gas through both meters until the whole or the greater part of the air is expelled from them. During this operation adjust the speed of the test meter by its outlet cock to the rate desired (91), and note the extent to which the cock is opened.

95. Close the cock L and as soon as the gas in both meters is compressed to the extent due to the acting pressure, the index of the test-meter should remain motionless. If it continues so for the space of a few minutes, the station-meter and its connections may be considered sound, but if any movement takes place, *leaks* must be sought for in the connections and about the meter case, by the aid of the *sense of smell alone*; unless the leak be *very trifling and the meter has had gas passing through it for a long time*; sufficiently long, in fact, to cause the measuring wheel to make several revolutions, for the application of a flame might lead to an *explosion*, which would be of *so serious* a nature with a large meter, that the slightest risk of it should be scrupulously avoided. Of course no danger of an explosion will ensue from the application of a light to a small hole in a meter which has had gas, and gas only, passing through it for a long time, if the inlet opening be much larger than the outlet, and the gas be supplied under a good pressure, but in testing it is most convenient generally to reduce the inlet to the large meter by the test-meter cock, as stated in the last paragraph. Sometimes the leaks may be discovered by the bubbles produced when fluid paint, soapy water or other liquid is brushed over the joints and connections.

REGISTRATION TESTS.

96. When the meter and connections have been proved to be gas-tight, the test for registration may be made in one of the

following ways. The first being usual, but far less reliable than the second.*

97. *First Method.*—Pass gas through the meters until the temporary pointer (see end of para. 93) reaches a pencil or other mark made on the edge of the index pot, or the index indicates an exact number of cubic feet, viz., 10, 100, 1000, or any other *whole* number, then close the cock of the test-meter and set its index (by turning the large hand backwards) to zero, re-open the test-meter cock to the required extent (94), and allow the gas to flow until the temporary pointer or the index of the station-meter shows that at least two revolutions of its measuring wheel have been made,† then instantly close the cock of the test-meter. Alter the water level within the station-meter and re-test as many times as may be needful until it agrees with the test-meter.

98. *Second Method.*—Close the cock L; open the test-meter cock to the required extent (91). The gas will enter both meters. Set the test-meter to zero or nearly so. Make a mark for a zero point a little in advance of the temporary pointer of the station-meter, or fix upon some figure on its dial in advance of the dial-pointer, and note what the index registration will be

* The Author has repeatedly, when verifying large station-meters, tried both methods, and feels confidence only in the second, for although theoretical considerations are insufficient to account for discrepancies, it is an actual fact that with the first method, very troublesome discrepancies do arise. It may be that these are in part due to the gearing of the indicating apparatus, which, in the second method, must be in close connection and perfect action.

† It is recommended to verify meters by the revolution of their measuring drums or wheels, and not by the revolution of the pointer index. There is scarcely a meter drum made in which the four chambers are *exactly* of the same cubic capacity, and the larger the drum the greater is the inequality likely to be. Hence its capacity can only be determined by one or more complete revolutions. Suppose the first dial of index show 100 cubic feet, and the capacity of the drum be 30 cubic feet, the drum must make in theory $3\frac{1}{3}$ revolutions to effect the revolution of the pointer, and although the measurement might appear right for the first 100 cubic feet, it might appear wrong for the second, and only right again on the third.

when the figure fixed upon is reached. Open the cock L. Both meters will commence working. Observe the test-meter index, and note its registration the instant an assistant gives a signal that the index or pointer of the station-meter has reached the figure or mark fixed upon. Continue the flow of gas until the assistant signals the completion of a revolution of the station-meter, and then instantly close the cock of the test-meter, and note the index of the latter, the difference between the first and last readings, if the temperature within both meters be the same, equals the capacity of the station-meter at the existing water-line.

Ex.—Test Meter index at the end of the Test	55.3
" " " commencement "	4.4
Capacity of Station Meter	50.9

Showing its water-line to be low, and its registration *slow* to the extent of 1.77 per cent. (see per-centage table).

99. If the temperature of the gas at the outlets of the two meters differs, the indicated volume must be corrected, and the calculation can only be conveniently made on the volume indicated by the test-meter.

RULE.—Calculate the difference in the volume of gas due to change of temperature (80 to 85). Add the difference to the indication of the test-meter if the gas issues from the station-meter at the *highest* temperature. Deduct the difference from the indication of the test-meter if the gas issues from the station-meter at the *lowest* temperature.

Ex.—Gas outlet Station Meter	65°
" " Test Meter	61°
Difference	4°
Ex.—Gas outlet Test Meter	58°
" " Station "	54°
Difference	4°

100. One per cent. on the 50.9 of par. 98 is .509, and this has in the first example to be added, making 51.409 as the capacity of the station-meter. In the second case it has to be deducted, leaving 50.391 as the capacity. The correction can also be made, and more easily, by rule par. 86.

101. When a meter is fixed and has been at work for some time it will be fair to assume that the connections are sound; hence, unless there are special reasons to the contrary, the "soundness test" may be omitted, and the test-meter may be attached to a pipe from the outlet of the station-meter, so that the gas shall first pass through the latter meter. The verification should be made after the manner described in paragraph 93 *et seq.* the flow the gas being wholly controlled by the test-meter cock, instead of being so in part by the cock L, fig. 21.

102. If a meter has to be verified under the *third* condition (92), adjust it to a perfect level by the aid of wedges, blocks, or other convenient means. Be careful also that the meter stands upright, that is to say, that the centre line indicated by punch or other marks on the front plate is vertical, this must be determined by the aid of a plumb line. Next charge the meter with water of, as nearly as possible, the same temperature as the surrounding atmosphere. Close the inlet of the meter (making a perfectly sound joint with yarn and lead putty) with a blank flange provided in its centre with a short nosepiece of 1 or $1\frac{1}{2}$ pipe. Close the outlet in the same way, but the blank flange must be provided with a cock answering to L fig. 21, and with a socket to receive a thermometer. Place the test-meter near to the meter to be tested, and proceed as directed in paragraph 93, &c.

VERIFICATION OF DRY METERS WITH A WET TEST-METER.

103. In the verification of large dry meters the test-meter *should generally* be applied to the outlet. The internal sound-

ness of the dry meter can in this way only be determined by passing gas at a low rate for some time and noting the indications of both indexes. If these agree, the verification may be proceeded with.

GAS OR AIR FOR METER TESTING, &c.

104. The present Sales of Gas Act permits the use of either gas or of air for the per-centage of error tests with gas meters. As a consequence, there is a diversity of practice among official meter inspectors. Some use gas for all the tests, while others limit the use of gas to the test for soundness (79), and use air for the registration tests. Now, as it seems to be a fact, that the registration of a dry meter is a little different when air is used to what it is when gas is used, uniformity of practice is much to be desired.

105. In a commercial sense the difference mentioned is as between buyer and seller of gas not important; but it is apparently sufficient to cause the rejection of a meter which has been some time in use, if such meter has been originally tested with air and then is re-tested with gas, or *vice versa*. The Author's inclination is for gas for all the tests, but then some consideration must be given to the local or other authorities who carry the Act into operation. Gas for all the tests with meters would, in many instances, mean heavy gas bills, whereas air is to be had for nothing more than a very little extra labour on the part of the employées. In some few small places, however, the use of air might necessitate the having of *two* gasholders where one now suffices, but uniformity of practice is the thing to be advocated, and this ought to prevail over all other considerations.

106. The influence of pressure when a meter is under test is another matter. Dry meters working at no greater rate than full speed seem to go a little faster in registration (at all events when new or nearly new), as the pressure is increased. Thus

dry meter, under five-tenths pressure, was found to be 1.42 per cent. fast, while under 2 inches pressure it was 1.73 per cent. fast. Another furnished similar results. This fact is somewhat remarkable, for although a larger volume of gas is actually delivered from a gasholder under high pressures than under low pressures for a certain length of stroke, the difference on the volumes so delivered under five-tenths and under 2 inches is very much less than is found to be indicated by the meters.

107. Mercury is 13.59 times heavier than water; hence, 30 inches (the height of a column representing the standard pressure of air) would be balanced by a water column 13.59×30 , or say, as near enough, 408 inches in height. The atmospheric pressure as a matter of course always operates in measurement and affects the volume or bulk of air or of gas—the pressures which are commonly mentioned, act in the way of compression precisely as would an increase in the atmospheric pressure. Thus, if the air pressure be normal, or equal to the support, in the tube of a water barometer, a water column 408 inches in height, the volume of air, say 10 cubic feet, contained within a perfectly balanced gasholder, would occupy the same space whether inclosed in the bell or not; but if the gasholder be weighted to the extent needful to cause the contained air to indicate one inch of water pressure; then the volume would be reduced in the ratio of 409 to 408 or from 10 cubic feet to 9.9755 cubic feet; but if 10 feet were actually contained by the bell under such pressure, then on removal of the inch pressure it would expand in the ratio of 408 to 409 and become 10.0245 cubic feet.

108. The lowest pressure under which gas is measured and used in meter-testing is five-tenths (which may be considered as the normal pressure for commercial measurement), and the highest 3 inches. The following represents measured volumes between those pressures calculated to standard.]

Five-tenths	10·0122	Diff.
Ten-tenths	10·0245	·0123
Fifteen-tenths	10·0378	·0123
Twenty-tenths	10·0490	·0122
Twenty-five-tenths	10·0613	·0123
Thirty-tenths	10·0735	·0122

109. It is thus evident that gas or air, when the barometer is at 30 inches, diminishes in bulk 0·122 per cent. for each half-inch of added pressure. The difference in volumes between gas or air measured respectively under five-tenths and 2 inches, is therefore 0·369 per cent.

110. Under different atmospheric pressures, the ratio of effect produced by added pressure of necessity changes; thus, 29 inches mercury of barometer pressure, represents 394 inches of water, and for half-an-inch and 2 inches added pressure, the ratios become 394 to 394·5 and 394 to 396. The corrected volumes for 10 feet of gas or air are therefore—

Five-tenths	10·0127
Twenty-tenths	10·0508

or 0·381 per cent. difference, equal 0·127 per cent. for every five-tenths of added pressure.

111. The increase in actual volume due to measuring the gas or air under higher pressures are, as already indicated, insufficient to account for the effect which the Author found when testing dry meters under different supply pressures, and if such effects are common to all dry meters, it may be fairly assumed that the higher pressures operating within a dry meter prevents so full a distension of the leathers as takes place when low pressures are employed, and that thus the higher pressure causes the meter to deliver a little less gas per complete action.

112. Wet meters under high pressures, or at high working speed, are affected in the reverse way, and for reasons given in

paragraph 36. Moreover, the direction of change is absolutely certain and trifling.

FURTHER NOTES ON TEMPERATURE CORRECTIONS.

113. In paragraphs 84 and 86 practical and sufficiently accurate rules for general purposes are given for temperature corrections; but if an approach to extreme accuracy is requisite, then the figures given in the Astronomer Royal's table must be used, but even then a little difficulty is encountered, for the table shows that 100 volumes of gas, saturated with aqueous vapour, when heated from 31.4° to 89.2° , expand to 116 volumes, or to the extent of 16 per cent.; and also that 116 volumes of gas, saturated with aqueous vapour, when cooled from 89.2° to 31.4° , contract to 100, or to the extent of 13.796 nearly per cent. If, therefore, the per-centage of reduction were calculated by the figures of table on the gas of highest temperature, then if the temperatures were as in the table 89.2° and 31.4° , the result would be wrong to the extent of the difference between 16 and 13.796 or 2.204 per cent., and so in varying proportions between other temperatures.

114. The Astronomer Royal's table exhibits the per-centage of dilatation on the original volume of gas at 31.4° Faht. Thus at 60.02° , the original 100 volumes have expanded to 107, and at 62° to $107\frac{1}{2}$, or to the additional extent of $\frac{1}{2}$ per cent. on the original volume at 31.4° . For ordinary purposes the per-centage of correction would be taken to be equal to the difference in volume at 60.02° and 62° , or $\frac{1}{2}$ per cent. calculated on the volume of gas used at temperature 60.02° , which is erroneous; for if 107 volumes at 60.02° only expand to 107.5 at 62° , it is evident that the increase must be something less than $\frac{1}{2}$ per cent., for this would give the volume at 62° as 107.535 instead of 107.5. If the true per-centage of increase is required, it *must* be found by proportion.

Volume of Gas by table at 60·02°	Volume of Gas at 31·4°	Per-centage of dilatation of the original volume from 60·02° to 62°	Per-centage of dilatation of the volume at 60·02° from 60·02° to 62°
107	100	·5	·4673.

The difference in the above instance is not very important, but suppose the temperature to be 60·02° and 70·9°, which by table would give 3 per cent.—

$$107 : 100 :: 3 : 2·8037.$$

and cause an error of one-fifth per cent. nearly.

115. The following is a completed calculation, and it is assumed that a meter has registered 100 cubic feet when passing gas at a lower temperature than at its issue from a gasholder, or from a test-meter.

EXAMPLE.—Temperature outlet of gasholder, 63·77°.

Temperature outlet of meter, 60·02°.

Per-centage of difference by table, 1 per cent.

Volume of Gas by table at 63·77°	Volume of Gas by table at 31·4°	Per-centage of difference by table between 63·77° and 60·02°	Per-centage of contraction from 63·77° to 60·02°
108	100	1	·92.

Gasholder reading at 63·77°, 106 cubic feet. ·92 per cent. on 106 = ·975 and 106—·975 = 105·025, or the correct gasholder reading for temperature 60·02°.

116. The per-centage number in the table will be the mean between those opposite 105·00 and 105·05, or 4·78 per cent. slow, the meter registering less than the volume of gas delivered through it.

OTHER METHODS OF USING THE CUBIC-FOOT BOTTLE.

117. The gas referees' cubic-foot measure, as used by the Examiners of the quality of gas in London for testing the experimental meters which are employed, is an egg-shaped vessel C, as shown in fig. 21, made of hardened tin about one quarter of an inch

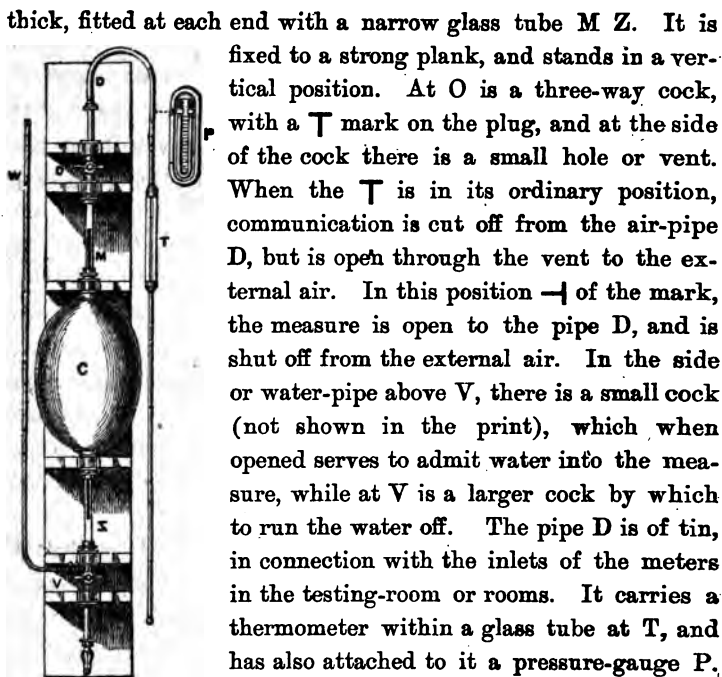


FIG. 21.

by narrow strips of paper pasted on, or by marks cut upon the glass tubes M Z. The instrument should be in communication with a tank of water, fed by a self-acting supply through the water pipe, and the lower level of the tank should be level with the top of the slip of paper or mark on M, indicating the "full" line of the measure.

118. The verification of the meters used with the photo-meters and the sulphur and ammonia tests is conducted as follows:—

Turn the three-way cock O, so as to leave the vent open to the air, and close the cock V, then open the cock on the water-pipe, and allow sufficient water to flow in to fill the glass tube

Z to the water line. Then turn O until the mark upon it is in this position —|. Next open the cock of the meter to be tested, taking care that all other connections are closed. Note the position of the pointers of the meters, and open the outlet of the meter to the air. Then gently open the cock on the water pipe, and allow the water to flow into the measure, just fast enough to cause the gauge P to indicate from half to three-quarter inch of pressure. The meter should make 12 revolutions, or indicate one cubic foot by the time the measure is full up to the mark on the glass tube M.

119. The referees' method requires a cubic foot of water to be used for every cubic foot of air measured, and demands much

care and watchfulness on the part of the operator. The Author's method has been described in paragraphs 40 and 41, the same water being used over and over again. As the advantages of this method has been already descanted upon, repetition is needless.

120. Recently, the Author has devised another method of using the bottle which promises well, but which has not yet been put into practical operation. The bottle will be mounted upon a strong cylinder,

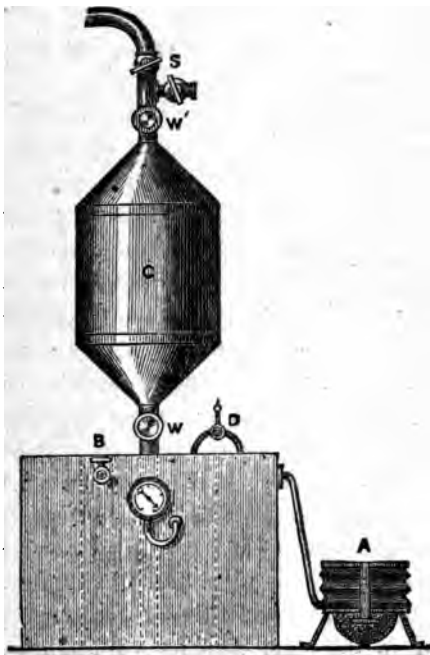


FIG. 22.

cal tank B, fig. 22, which is divided internally into two annular chambers. The lower neck of the bottle is prolonged by means of a pipe which descends very nearly to the bottom of the inner chamber. This latter will be of sufficient capacity to hold about $1\frac{1}{4}$ cubic feet of water. The capacity of the outer chamber will be about 2 cubic feet, and the only connection between it and the inner chamber will be through the cock D. A small Bourdon gauge, in connection with the outer chamber, will be fixed on the front of the tank, and beside it a vent cock communicating with the inner chamber. W W' represents openings through the necks of the bottle, and these of course will be covered by glass and made water and air tight by screwed caps. S is a stop cock, and just below it is a vent cock. A is a pair of strong foot bellows, which it is thought will answer the purpose, but if they do not, an air pump will be employed.

121. The operations will be as follows:—with the cock below B open, the required quantity of water will be poured into the inner chamber through a cock and funnel not shown in the woodcut. The funnel will then be removed and the charging cock and the cock below B closed. Next air will be compressed into the outer chamber until 15 to 20 lbs. pressure are indicated on the gauge. The vent cock on the upper neck of the bottle will then be opened and D will be turned on to a very small extent. As soon as the air entering the inner chamber has caused the water to rise and appear in W, the further entry of air will be stopped by closing D. The upper vent cock will be closed and the delivery cock S opened. D will then again be opened and as soon as water appears at W' the delivery cock S will be first closed then D also immediately after. On opening the upper and lower air vent cocks, the water will quietly descend into the inner chamber. In the operation of discharging air from the bottle, the air in the outer chamber will diminish in volume and in pressure and these will have to be made up,

between every discharge, by forcing in more air by means of the bellows or air pump.

122. The Author believes that this method will work well and his object in devising it was to produce a more compact arrangement than his original one.

COMPENSATION OF GASHOLDERS.

123. The best known method of compensating for the loss of weight caused by the immersion of the bell in water is described in par. 21, but recently the old fashioned method of compensating by means of a chain was revived by the Meter Inspector of Edinburgh. In this system of compensation the chain requires to be of such weight that a length equal to the stroke of the bell shall be half the weight which the bell loses by immersion. Thus, if the stroke of the bell be 3 feet and the loss of weight 6 lbs., then each foot length of the chain must weigh *one pound*. The reason for this is almost self evident, for in the descent of the bell, not only does a foot of chain pass over the wheel and add to the effective weight operating on the side of wheel immediately over the centre of the bell, but one foot of the chain is also removed from the opposing or counterpoise side. The holders mentioned in par. 6 was compensated in this way, a band studded with strips of lead being used instead of a chain.

124. The system is altogether objectionable for Standard instruments, inasmuch as in the event of the bell becoming altered in the weight of its cylinder, from any cause, every link of the chain would need alteration, or a new chain might have to be substituted; while with the method described in par. 21 any needful alteration can be made in a few minutes. Had the Government instruments been compensated by the antiquated chain method, the re-adjustment, which became necessary after

about 16 years of use, would have been a matter of much labour and cost; as it was, the re-adjustment was effected in very little time and without disturbing any of the fittings beyond the compensating weights, which were a little lightened. Again, if a new bell be wanted for a gasholder and the thickness of its metal differs from that of the original bell, the weight and curve compensation renders adjustment very easy and inexpensive.

AMENDMENT OF THE SALES OF GAS ACT.

125. The present Act has always been regarded as imperfect and successive Governments have been urged to amend it or to supersede it by a new Act. In 1871 the Author, in a paper read by him at the meeting of the B. A. Gas Managers, advocated the re-verification of meters at Moderate Intervals of Time—The Compulsory adoption of the Act by Local Authorities and its Application in every Borough and City in the Kingdom—The Testing of Indexes—The Formulation of Precise Rules to be observed in Meter Testing.

126. The Board of Trade have for a long time had the Sales of Gas Act under consideration and will, without doubt, get a new Act passed at an early date. The Author has reason to believe that its provisions will render necessary the periodical re-verification of gas meters. Suggestions have been made that the Act should be adopted and put into operation by Local Authorities, who, from lapse of time, are barred by the present Act from doing so. It should compel any Local Authority who have adopted, or who may adopt, the Act, to put it completely into operation, there being some few places where, although the Act has been adopted, it is very imperfectly carried into effect. Besides this, the Board of Trade should, and may probably, take power itself to appoint an Inspector in a district, if deemed necessary, and to provide him with the requisite apparatus.

127. Specific rules should be drawn up for meter testing, but whether these should be contained in the new Act or be issued as instructions by the Board of Trade is a question for consideration. It has also been suggested that the number of tests should be increased, and that meters in future should be subjected to a test for soundness as at present—for registration under different pressures and at different speeds,* as well as for *steadiness* of lights when working at full speed, and finally that the indexes shall be tested when separated from the meters. The Author has advocated the testing of indexes when fixed to the meter, but fancies that “the powers that be” see some objections to this plan. Under the present Act, no power is *actually given* to an inspector to reject a meter for *unsteadiness of lights*, but he certainly would hesitate to stamp such a meter, while it would be objected to, both by buyer and seller of gas.

128. It is to be hoped also that provision will be made for the testing of large meters, such as are described in 51, and following paragraphs, at low speeds and low pressures, for with meters fixed for use, and for the testing of which the test-meter (24) must be employed, high pressures and full speed are impossible, as full speed is also, even when a gasholder is employed. Unless some provision be made in this respect, it will be really illegal to use a legalised instrument, and impossible, in fact, to make any test whatever which would comply with the law. Such is the state of matters now, and such they would remain.

129. Many meters have of necessity been tested at low speed and at low pressure, and although such meters are, without doubt, correct, yet if disputes were to arise between the buyer and seller of gas, and a question were raised in a Court of Law as to the legality of the mode of testing, it can scarcely be doubtful what the issue would be.

* Paragraphs 106—112.

130. Again, provision is required for the verification of meters of all sizes, wet and dry, which are to be used for experimental purposes. Wet meters of this kind generally have the water-line defined by a gauge similar in principle to that described in paragraph 53. Such meters *are* "capable of being made . . . by increase or decrease of water . . . to register quantities varying from the true standard measure of gas" by more than 2 per cent. fast, and more than 3 per cent. slow, but yet are *good* meters, and although they are not used to measure gas for sale, many are used for the no less important purpose of measuring the gas when its purity and illuminating power have to be ascertained, hence the verification of such meters is alike important to the public and to Gas Companies. At present an inspector may test such a meter as a private matter, but he has no power to stamp it with the official seal issued to him by the Board of Trade.

FORMS OF BOOKS, CERTIFICATES, &c.

131. The Metropolitan Board of Works has caused very convenient forms of books, &c., to be drawn up for use at its meter-testing stations. These forms are less elaborate, and generally better, than those given in former editions of "Gas Meter-Testing," and through the agency of Mr. George Mills, Metropolitan Board of Works' Inspector at Westminster, the Author is able to give them, and in so doing wishes to acknowledge his appreciation of the ready and kindly way in which Mr. Mills met his request for copies.

132. The principal book is the "Register" Form A, in which a few, but a sufficient number of illustrative entries are shown, for, as a matter of course, the entries in the registers at the Board of Works Stations are very numerous. It will be observed that in respect to fees there is a ledger or credit column; the Board of Works preferring monthly to immediate cash

settlements with Gas Companies or Meter Makers, who are constantly sending meters to be tested. The "Cash Received" column and the "Ledger Account" column are totalled every week, and a statement made out on the Form B, the cash received (which is also registered on the counterfoils of the numbered receipts given) being paid over by the Inspector after the end of each week to an auditor who visits the testing station on every Monday, and who, after the examination of the register, signs it, as he does also a small voucher book similar in its contents to B; which book is retained by the Inspector.

133. Statements are rendered to those who have monthly accounts on the Form C, and the sum due is, in London, paid to the Inspector, generally by a cheque payable to his order, and he gives the receipt. The "Ledger" needs no description.

134. Certificates are of two kinds, namely, that for a single meter, Form D, and that for a number of meters, Form E, for a Gas Company or a Meter Maker.

135. Reverting to Form A, it will be observed that it contains no column for recording differences in temperature (85, 86), or of the corrections made therefore, such record not being deemed essential. In case, therefore, of any difference being found, the Inspector would correct the indication of the volume delivered from the gasholder, and insert the corrected result in the register.

136. If in any new Act the tests should be increased in number (127), then the columns under "Quantity of Gas or Air passed," and under "Maximum per cent.," will also need increasing, and, doubtless, the Board of Works would so far modify the register.

137. The Board has no form to be filled up and delivered along with meters which are to be tested. Gas Companies and Meter Makers provide their own delivery notes. Gas-fitters or consumers delivering one or several meters, should set out in a

note the size or sizes, maker's name, and number or numbers. Meters are, however, frequently received without any note, and its reception at once, or as soon as possible, recorded in the register.

138. The fees at present chargeable for ordinary meters are as follows, but if the number of tests be increased, no doubt the fees will be raised :—

No. of Lights.	Dry Meters.		Wet Meters.	
	s.	d.	s.	d.
1	0	6	0	6
2	0	6	0	6
3	0	6.	0	6
5	0	6	0	6
10	1	0	1	0
20	1	0	1	0
30	1	0	1	0
50	1	0	2	0
60	1	0	3	0
80	2	0	4	0
100	3	0	5	0
150	5	0	8	0

Large meters of the station-meter type (51), are, if taken to the Inspector's Office, charged for at the rate of one shilling per cubic foot of registering capacity per revolution or complete action, but if the meter be tested on a consumer's premises, it is usual on the part of the Board of Works to charge a double fee, and also the expenses incurred for cartage of the necessary instruments to and from the consumer's premises—whether legally or not has not yet been contested.

PER-CENTAGE TABLES.

Showing the *per-centage of error* in meters whose registration differs from the indications of the test gasholders.

Extracted from an extended table, compiled and printed by order of the Metropolitan Board of Works, for the use of their Meter Inspectors.

+ signifies *Fast*.

— „ *Slow*.

Meter Registering 2 feet.		Meter Registering 5 feet.		Meter Registering 5 feet.		Meter Registering 5 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
1-80	+ 11-11	4-50	+ 11-11	96	+ 0-81	42	- 7-75
81	+ 10-50	51	+ 10-86	97	+ 0-60	43	- 7-92
82	+ 9-89	52	+ 10-62	98	+ 0-40	44	- 8-09
83	+ 9-29	53	+ 10-38	99	+ 0-20	45	- 8-26
84	+ 8-70	54	+ 10-13	5-00	Nil.	46	- 8-42
85	+ 8-11	55	+ 9-89	01	- 0-20	47	- 8-59
86	+ 7-53	56	+ 9-65	02	- 0-40	48	- 8-76
87	+ 6-95	57	+ 9-41	03	- 0-60	49	- 8-93
88	+ 6-38	58	+ 9-17	04	- 0-79	5-50	- 9-09
89	+ 5-82	59	+ 8-93	05	- 0-99	51	- 9-26
1-90	+ 5-26	4-60	+ 8-70	06	- 1-19	52	- 9-42
91	+ 4-71	61	+ 8-46	07	- 1-38	53	- 9-59
92	+ 4-17	62	+ 8-23	08	- 1-57	54	- 9-75
93	+ 3-63	63	+ 7-99	09	- 1-77	55	- 9-91
94	+ 3-09	64	+ 7-76	5-10	- 1-96	56	- 10-07
95	+ 2-56	65	+ 7-53	11	- 2-15	57	- 10-23
96	+ 2-04	66	+ 7-30	12	- 2-34	58	- 10-39
97	+ 1-52	67	+ 7-07	13	- 2-53	59	- 10-55
98	+ 1-01	68	+ 6-84	14	- 2-72	5-00	- 10-71
99	+ 0-50	69	+ 6-61	15	- 2-91	61	- 10-87
2-00	Nil.	4-70	+ 6-38	16	- 3-10	62	- 11-03
01	- 0-50	71	+ 6-16	17	- 3-29	63	- 11-19
02	- 0-99	72	+ 5-93	18	- 3-47		
03	- 1-48	73	+ 5-71	19	- 3-66		
04	- 1-96	74	+ 5-49	5-20	- 3-85		
05	- 2-44	75	+ 5-26	21	- 4-03		
06	- 2-91	76	+ 5-04	22	- 4-21		
07	- 3-38	77	+ 4-82	23	- 4-40		
08	- 3-85	78	+ 4-60	24	- 4-58		
09	- 4-31	79	+ 4-38	25	- 4-76		
2-10	- 4-76	4-80	+ 4-17	26	- 4-94		
11	- 5-21	81	+ 3-95	27	- 5-12		
12	- 5-66	82	+ 3-73	28	- 5-30		
13	- 6-10	83	+ 3-52	29	- 5-48		
14	- 6-54	84	+ 3-31	5-30	- 5-66		
15	- 6-98	85	+ 3-09	31	- 5-84		
16	- 7-41	86	+ 2-88	32	- 6-02		
17	- 7-83	87	+ 2-67	33	- 6-19		
18	- 8-26	88	+ 2-46	34	- 6-37		
19	- 8-68	89	+ 2-25	35	- 6-54		
2-20	- 9-09	4-90	+ 2-04	36	- 6-72		
21	- 9-50	91	+ 1-83	37	- 6-89		
22	- 9-91	92	+ 1-63	38	- 7-06		
23	- 10-31	93	+ 1-42	39	- 7-24		
24	- 10-71	94	+ 1-21	5-40	- 7-41		
25	- 11-11	95	+ 1-01	41	- 7-58		

Meter Registering 10 feet.		Meter Registering 10 feet.		Meter Registering 10 feet.		Meter Registering 10 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
9-00	+ 11-11	-46	+ 5-71	-92	+ 0-81	-38	- 3-66
-01	+ 10-99	-47	+ 5-60	-93	+ 0-70	-39	- 3-75
-02	+ 10-86	-48	+ 5-49	-94	+ 0-60	10-40	- 3-85
-03	+ 10-74	-49	+ 5-37	-95	+ 0-50	-41	- 3-94
-04	+ 10-62	9-50	+ 5-26	-96	+ 0-40	-42	- 4-03
-05	+ 10-50	-51	+ 5-15	-97	+ 0-30	-43	- 4-12
-06	+ 10-38	-52	+ 5-04	-98	+ 0-20	-44	- 4-21
-07	+ 10-25	-53	+ 4-93	-99	+ 0-10	-45	- 4-31
-08	+ 10-13	-54	+ 4-82	10-00	Nil.	-46	- 4-40
-09	+ 10-01	-55	+ 4-71	-01	- 0-10	-47	- 4-49
9-10	+ 9-89	-56	+ 4-60	-02	- 0-20	-48	- 4-58
-11	+ 9-77	-57	+ 4-49	-03	- 0-30	-49	- 4-67
-12	+ 9-65	-58	+ 4-38	-04	- 0-40	10-50	- 4-76
-13	+ 9-53	-59	+ 4-28	-05	- 0-50	-51	- 4-85
-14	+ 9-41	9-60	+ 4-17	-06	- 0-60	-52	- 4-94
-15	+ 9-29	-61	+ 4-06	-07	- 0-70	-53	- 5-03
-16	+ 9-17	-62	+ 3-95	-08	- 0-79	-54	- 5-12
-17	+ 9-05	-63	+ 3-84	-09	- 0-89	-55	- 5-21
-18	+ 8-93	-64	+ 3-73	10-10	- 0-99	-56	- 5-30
-19	+ 8-81	-65	+ 3-63	-11	- 1-09	-57	- 5-39
9-20	+ 8-70	-66	+ 3-52	-12	- 1-19	-58	- 5-48
-21	+ 8-58	-67	+ 3-41	-13	- 1-28	-59	- 5-57
-22	+ 8-46	-68	+ 3-31	-14	- 1-38	10-60	- 5-66
-23	+ 8-34	-69	+ 3-20	-15	- 1-48	-61	- 5-75
-24	+ 8-23	9-70	+ 3-09	-16	- 1-57	-62	- 5-84
-25	+ 8-11	-71	+ 2-99	-17	- 1-67	-63	- 5-93
-26	+ 7-99	-72	+ 2-88	-18	- 1-77	-64	- 6-02
-27	+ 7-87	-73	+ 2-77	-19	- 1-86	-65	- 6-10
-28	+ 7-76	-74	+ 2-67	10-20	- 1-96	-66	- 6-19
-29	+ 7-64	-75	+ 2-56	-21	- 2-06	-67	- 6-28
9-30	+ 7-53	-76	+ 2-46	-22	- 2-15	-68	- 6-37
-31	+ 7-41	-77	+ 2-35	-23	- 2-25	-69	- 6-45
-32	+ 7-30	-78	+ 2-25	-24	- 2-34	10-70	- 6-54
-33	+ 7-18	-79	+ 2-15	-25	- 2-44	-71	- 6-63
-34	+ 7-07	9-80	+ 2-04	-26	- 2-53	-72	- 6-72
-35	+ 6-95	-81	+ 1-94	-27	- 2-63	-73	- 6-80
-36	+ 6-84	-82	+ 1-83	-28	- 2-72	-74	- 6-89
-37	+ 6-72	-83	+ 1-73	-29	- 2-82	-75	- 6-98
-38	+ 6-61	-84	+ 1-63	10-30	- 2-91	-76	- 7-06
-39	+ 6-50	-85	+ 1-52	-31	- 3-01	-77	- 7-15
9-40	+ 6-38	-86	+ 1-42	-32	- 3-10	-78	- 7-24
-41	+ 6-27	-87	+ 1-32	-33	- 3-19	-79	- 7-32
-42	+ 6-16	-88	+ 1-21	-34	- 3-29	10-80	- 7-41
-43	+ 6-04	-89	+ 1-11	-35	- 3-38	-81	- 7-49
-44	+ 5-93	9-90	+ 1-01	-36	- 3-47	-82	- 7-58
-45	+ 5-82	-91	+ 0-91	-37	- 3-57	-83	- 7-66

Meter Registering 10 feet.		Meter Registering 20 feet.		Meter Registering 20 feet.		Meter Registering 20 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
84	- 7-75	18-00	+ 11-11	46	+ 8-34	92	+ 5-71
85	- 7-83	01	+ 11-05	47	+ 8-29	93	+ 5-65
86	- 7-92	02	+ 10-99	48	+ 8-23	94	+ 5-60
87	- 8-00	03	+ 10-92	49	+ 8-17	95	+ 5-54
88	- 8-09	04	+ 10-86	18-50	+ 8-11	96	+ 5-49
89	- 8-17	05	+ 10-80	51	+ 8-05	97	+ 5-43
10-90	- 8-26	06	+ 10-74	52	+ 7-99	98	+ 5-37
91	- 8-34	07	+ 10-68	53	+ 7-93	99	+ 5-31
92	- 8-42	08	+ 10-62	54	+ 7-87	19-00	+ 5-26
93	- 8-51	09	+ 10-56	55	+ 7-82	01	+ 5-20
94	- 8-59	18-10	+ 10-50	56	+ 7-76	02	+ 5-15
95	- 8-68	11	+ 10-44	57	+ 7-70	03	+ 5-09
96	- 8-76	12	+ 10-38	58	+ 7-64	04	+ 5-04
97	- 8-84	13	+ 10-31	59	+ 7-59	05	+ 4-98
98	- 8-93	14	+ 10-25	18-60	+ 7-53	06	+ 4-93
99	- 9-01	15	+ 10-19	61	+ 7-47	07	+ 4-87
11-00	- 9-09	16	+ 10-13	62	+ 7-41	08	+ 4-82
01	- 9-18	17	+ 10-07	63	+ 7-36	09	+ 4-76
02	- 9-26	18	+ 10-01	64	+ 7-30	19-10	+ 4-71
03	- 9-34	19	+ 9-95	65	+ 7-24	11	+ 4-65
04	- 9-42	18-20	+ 9-89	66	+ 7-18	12	+ 4-60
05	- 9-51	21	+ 9-83	67	+ 7-13	13	+ 4-54
06	- 9-59	22	+ 9-77	68	+ 7-07	14	+ 4-49
07	- 9-67	23	+ 9-71	69	+ 7-01	15	+ 4-43
08	- 9-75	24	+ 9-65	18-70	+ 6-95	16	+ 4-38
09	- 9-83	25	+ 9-59	71	+ 6-90	17	+ 4-33
11-10	- 9-91	26	+ 9-53	72	+ 6-84	18	+ 4-28
11	- 9-99	27	+ 9-47	73	+ 6-78	19	+ 4-22
12	- 10-07	28	+ 9-41	74	+ 6-72	19-20	+ 4-17
13	- 10-15	29	+ 9-35	75	+ 6-66	21	+ 4-11
14	- 10-23	18-30	+ 9-29	76	+ 6-61	22	+ 4-06
15	- 10-31	31	+ 9-23	77	+ 6-55	23	+ 4-00
16	- 10-39	32	+ 9-17	78	+ 6-50	24	+ 3-95
17	- 10-47	33	+ 9-11	79	+ 6-44	25	+ 3-89
18	- 10-55	34	+ 9-05	18-80	+ 6-38	26	+ 3-84
19	- 10-63	35	+ 8-99	81	+ 6-32	27	+ 3-78
11-20	- 10-71	36	+ 8-93	82	+ 6-27	28	+ 3-73
21	- 10-79	37	+ 8-87	83	+ 6-21	29	+ 3-68
22	- 10-87	38	+ 8-81	84	+ 6-16	19-30	+ 3-63
23	- 10-95	39	+ 8-76	85	+ 6-10	31	+ 3-57
24	- 11-03	18-40	+ 8-70	86	+ 6-04	32	+ 3-52
25	- 11-11	41	+ 8-64	87	+ 5-98	33	+ 3-46
		42	+ 8-58	88	+ 5-93	34	+ 3-41
		43	+ 8-52	89	+ 5-87	35	+ 3-36
		44	+ 8-46	18-90	+ 5-82	36	+ 3-31
		45	+ 8-40	91	+ 5-76	37	+ 3-25

Meter Registering 20 feet.		Meter Registering 20 feet.		Meter Registering 20 feet.		Meter Registering 20 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
38	+ 3.20	84	+ 0.81	20.00	- 2.01	52	- 7.10
39	+ 3.14	85	+ 0.75	62	- 3.01	54	- 7.15
19.40	+ 3.09	86	+ 0.70	64	- 3.10	56	- 7.24
41	+ 3.04	87	+ 0.65	66	- 3.19	58	- 7.32
42	+ 2.99	88	+ 0.60	68	- 3.29	21.00	- 7.41
43	+ 2.93	89	+ 0.55	20.70	- 3.38	62	- 7.49
44	+ 2.88	19.90	+ 0.50	72	- 3.47	64	- 7.58
45	+ 2.82	91	+ 0.45	74	- 3.57	66	- 7.66
46	+ 2.77	92	+ 0.40	76	- 3.66	68	- 7.75
47	+ 2.72	93	+ 0.35	78	- 3.75	21.70	- 7.83
48	+ 2.67	94	+ 0.30	20.80	- 3.85	72	- 7.92
49	+ 2.61	95	+ 0.25	82	- 3.94	74	- 8.00
19.50	+ 2.56	96	+ 0.20	84	- 4.03	76	- 8.09
51	+ 2.51	97	+ 0.15	86	- 4.12	78	- 8.17
52	+ 2.46	98	+ 0.10	88	- 4.21	21.80	- 8.26
53	+ 2.40	99	+ 0.05	20.90	- 4.31	82	- 8.34
54	+ 2.35	20.00	Nil.	92	- 4.40	84	- 8.42
55	+ 2.30	02	- 0.10	94	- 4.49	86	- 8.51
56	+ 2.25	04	- 0.20	96	- 4.58	88	- 8.59
57	+ 2.20	06	- 0.30	98	- 4.67	21.90	- 8.68
58	+ 2.15	08	- 0.40	21.00	- 4.76	92	- 8.76
59	+ 2.09	20.10	- 0.50	02	- 4.85	94	- 8.84
19.60	+ 2.04	12	- 0.60	04	- 4.94	96	- 8.93
61	+ 1.99	14	- 0.70	06	- 5.03	98	- 9.01
62	+ 1.94	16	- 0.79	08	- 5.12	22.00	- 9.10
63	+ 1.88	18	- 0.89	21.10	- 5.21	02	- 9.18
64	+ 1.83	20.20	- 0.99	12	- 5.30	04	- 9.26
65	+ 1.78	22	- 1.09	14	- 5.39	06	- 9.34
66	+ 1.73	24	- 1.19	16	- 5.48	08	- 9.42
67	+ 1.68	26	- 1.28	18	- 5.57	22.10	- 9.51
68	+ 1.63	28	- 1.38	21.20	- 5.66	12	- 9.59
69	+ 1.57	20.30	- 1.48	22	- 5.75	14	- 9.67
19.70	+ 1.52	32	- 1.57	24	- 5.84	16	- 9.75
71	+ 1.47	34	- 1.67	26	- 5.93	18	- 9.83
72	+ 1.42	36	- 1.77	28	- 6.02	22.20	- 9.91
73	+ 1.37	38	- 1.86	21.30	- 6.10	22	- 9.99
74	+ 1.32	20.40	- 1.96	32	- 6.19	24	- 10.07
75	+ 1.26	42	- 2.06	34	- 6.28	26	- 10.15
76	+ 1.21	44	- 2.15	36	- 6.37	28	- 10.23
77	+ 1.16	46	- 2.25	38	- 6.46	22.30	- 10.31
78	+ 1.11	48	- 2.34	21.40	- 6.54	32	- 10.39
79	+ 1.06	20.50	- 2.44	42	- 6.63	34	- 10.47
19.80	+ 1.01	52	- 2.53	44	- 6.72	36	- 10.55
81	+ 0.96	54	- 2.63	46	- 6.80	38	- 10.63
82	+ 0.91	56	- 2.73	48	- 6.89	22.40	- 10.71
83	+ 0.86	58	- 2.82	21.50	- 6.98	42	- 10.79

Meter Registering 20 feet.		Meter Registering 30 feet.		Meter Registering 30 feet.		Meter Registering 30 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
44	- 10-87	27-00	+ 11-11	92	+ 7-15	84	+ 4-02
46	- 10-95	02	+ 11-03	04	+ 7-38	86	+ 3-95
48	- 11-03	04	+ 10-95	06	+ 7-30	88	+ 3-88
22-50	- 11-11	06	+ 10-86	08	+ 7-22	28-90	+ 3-81
		08	+ 10-78	28-00	+ 7-14	02	+ 3-73
		27-10	+ 10-70	02	+ 7-07	04	+ 3-66
		12	+ 10-62	04	+ 6-99	06	+ 3-59
		14	+ 10-54	06	+ 6-92	08	+ 3-52
		16	+ 10-46	08	+ 6-84	20-00	+ 3-45
		18	+ 10-38	28-10	+ 6-76	02	+ 3-38
		27-20	+ 10-30	12	+ 6-69	04	+ 3-31
		22	+ 10-21	14	+ 6-61	06	+ 3-24
		24	+ 10-13	16	+ 6-53	08	+ 3-16
		26	+ 10-05	18	+ 6-46	20-10	+ 3-09
		28	+ 9-97	28-20	+ 6-38	12	+ 3-02
		27-30	+ 9-89	22	+ 6-31	14	+ 2-95
		32	+ 9-81	24	+ 6-23	16	+ 2-88
		34	+ 9-73	26	+ 6-16	18	+ 2-81
		36	+ 9-65	28	+ 6-08	20-20	+ 2-74
		38	+ 9-57	28-30	+ 6-01	22	+ 2-67
		27-40	+ 9-49	32	+ 5-93	24	+ 2-60
		42	+ 9-41	34	+ 5-86	26	+ 2-53
		44	+ 9-33	36	+ 5-78	28	+ 2-46
		46	+ 9-25	38	+ 5-71	20-30	+ 2-39
		48	+ 9-17	28-40	+ 5-63	32	+ 2-32
		27-50	+ 9-09	42	+ 5-56	34	+ 2-25
		52	+ 9-01	44	+ 5-49	36	+ 2-18
		54	+ 8-93	46	+ 5-41	38	+ 2-11
		56	+ 8-85	48	+ 5-34	20-40	+ 2-04
		58	+ 8-78	28-50	+ 5-26	42	+ 1-97
		27-60	+ 8-70	52	+ 5-19	44	+ 1-90
		62	+ 8-62	54	+ 5-11	46	+ 1-83
		64	+ 8-54	56	+ 5-04	48	+ 1-76
		66	+ 8-46	58	+ 4-96	20-50	+ 1-69
		68	+ 8-38	28-60	+ 4-89	52	+ 1-63
		27-70	+ 8-31	62	+ 4-82	54	+ 1-56
		72	+ 8-23	64	+ 4-75	56	+ 1-49
		74	+ 8-15	66	+ 4-67	58	+ 1-42
		76	+ 8-07	68	+ 4-60	20-60	+ 1-35
		78	+ 7-99	28-70	+ 4-53	62	+ 1-28
		27-80	+ 7-92	72	+ 4-45	64	+ 1-21
		82	+ 7-84	74	+ 4-38	66	+ 1-14
		84	+ 7-76	76	+ 4-31	68	+ 1-08
		86	+ 7-68	78	+ 4-24	20-70	+ 1-01
		88	+ 7-61	28-80	+ 4-17	72	+ 0-94
		27-90	+ 7-53	82	+ 4-10	74	+ 0-88

Meter Registering 30 feet.		Meter Registering 30 feet.		Meter Registering 30 feet.		Meter Registering 30 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
.76	+ 0.81	.68	- 2.22	31.60	- 5.06	.52	- 7.76
.78	+ 0.74	30.70	- 2.28	.62	- 5.12	.54	- 7.82
29.80	+ 0.67	.72	- 2.34	.64	- 5.18	.56	- 7.87
.82	+ 0.60	.74	- 2.40	.66	- 5.24	.58	- 7.93
.84	+ 0.53	.76	- 2.47	.68	- 5.30	32.60	- 7.98
.86	+ 0.47	.78	- 2.53	31.70	- 5.36	.62	- 8.04
.88	+ 0.40	30.80	- 2.60	.72	- 5.42	.64	- 8.10
29.90	+ 0.33	.82	- 2.66	.74	- 5.48	.66	- 8.15
.92	+ 0.26	.84	- 2.72	.76	- 5.54	.68	- 8.21
.94	+ 0.20	.86	- 2.78	.78	- 5.60	32.70	- 8.26
.96	+ 0.13	.88	- 2.85	31.80	- 5.66	.72	- 8.32
.98	+ 0.07	30.90	- 2.91	.82	- 5.72	.74	- 8.37
30.00	Nil.	.92	- 2.97	.84	- 5.78	.76	- 8.43
.02	- 0.07	.94	- 3.04	.86	- 5.84	.78	- 8.49
.04	- 0.13	.96	- 3.10	.88	- 5.90	32.80	- 8.54
.06	- 0.20	.98	- 3.16	31.90	- 5.96	.82	- 8.60
.08	- 0.27	31.00	- 3.22	.92	- 6.02	.84	- 8.66
30.10	- 0.33	.02	- 3.29	.94	- 6.08	.86	- 8.71
.12	- 0.40	.04	- 3.35	.96	- 6.13	.88	- 8.77
.14	- 0.47	.06	- 3.42	.98	- 6.19	32.90	- 8.82
.16	- 0.53	.08	- 3.48	32.00	- 6.25	.92	- 8.87
.18	- 0.60	31.10	- 3.54	.02	- 6.31	.94	- 8.93
30.20	- 0.66	.12	- 3.60	.04	- 6.37	.96	- 8.99
.22	- 0.73	.14	- 3.66	.06	- 6.42	.98	- 9.04
.24	- 0.79	.16	- 3.72	.08	- 6.48	33.00	- 9.09
.26	- 0.86	.18	- 3.79	32.10	- 6.54	.02	- 9.15
.28	- 0.92	31.20	- 3.85	.12	- 6.60	.04	- 9.20
30.30	- 0.99	.22	- 3.91	.14	- 6.66	.06	- 9.26
.32	- 1.06	.24	- 3.97	.16	- 6.72	.08	- 9.31
.34	- 1.12	.26	- 4.03	.18	- 6.77	33.10	- 9.36
.36	- 1.19	.28	- 4.09	32.20	- 6.83	.12	- 9.42
.38	- 1.26	31.30	- 4.16	.22	- 6.89	.14	- 9.47
30.40	- 1.32	.32	- 4.22	.24	- 6.95	.16	- 9.53
.42	- 1.38	.34	- 4.28	.26	- 7.01	.18	- 9.59
.44	- 1.44	.36	- 4.34	.28	- 7.07	33.20	- 9.64
.46	- 1.51	.38	- 4.40	32.30	- 7.13	.22	- 9.70
.48	- 1.57	31.40	- 4.46	.32	- 7.18	.24	- 9.75
30.50	- 1.64	.42	- 4.52	.34	- 7.24	.26	- 9.81
.52	- 1.71	.44	- 4.58	.36	- 7.30	.28	- 9.86
.54	- 1.77	.46	- 4.64	.38	- 7.36	33.30	- 9.91
.56	- 1.83	.48	- 4.70	32.40	- 7.41	.32	- 9.96
.58	- 1.89	31.50	- 4.76	.42	- 7.47	.34	- 10.01
30.60	- 1.96	.52	- 4.82	.44	- 7.53	.36	- 10.07
.62	- 2.02	.54	- 4.88	.46	- 7.59	.38	- 10.12
.64	- 2.09	.56	- 4.94	.48	- 7.64	33.40	- 10.18
.66	- 2.15	.58	- 5.00	32.50	- 7.70	.42	- 10.23

Meter Registering 30 feet.		Meter Registering 40 feet.		Meter Registering 40 feet.		Meter Registering 40 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
44	- 10-28	36-00	+ 11-11	42	+ 8-34	84	+ 5-71
46	- 10-34	42	+ 11-05	44	+ 8-29	86	+ 5-65
48	- 10-39	44	+ 10-99	46	+ 8-23	88	+ 5-60
33-50	- 10-45	46	+ 10-92	48	+ 8-17	37-90	+ 5-54
52	- 10-50	48	+ 10-86	37-00	+ 8-11	42	+ 5-49
54	- 10-55	36-10	+ 10-80	42	+ 8-05	44	+ 5-43
56	- 10-61	42	+ 10-74	44	+ 7-99	46	+ 5-37
58	- 10-66	44	+ 10-68	46	+ 7-93	48	+ 5-31
33-60	- 10-71	46	+ 10-62	48	+ 7-87	38-00	+ 5-26
62	- 10-76	48	+ 10-56	37-10	+ 7-82	42	+ 5-20
64	- 10-82	36-20	+ 10-50	42	+ 7-76	44	+ 5-15
66	- 10-87	42	+ 10-44	44	+ 7-70	46	+ 5-09
68	- 10-93	44	+ 10-38	46	+ 7-64	48	+ 5-04
33-70	- 10-98	46	+ 10-31	48	+ 7-59	38-10	+ 4-98
72	- 11-03	48	+ 10-25	37-20	+ 7-53	42	+ 4-93
74	- 11-09	36-30	+ 10-19	42	+ 7-47	44	+ 4-87
76	- 11-14	42	+ 10-13	44	+ 7-41	46	+ 4-82
78	- 11-19	44	+ 10-07	46	+ 7-36	48	+ 4-76
		46	+ 10-01	48	+ 7-30	38-20	+ 4-71
		48	+ 9-95	37-30	+ 7-24	42	+ 4-65
		36-40	+ 9-89	42	+ 7-18	44	+ 4-60
		42	+ 9-83	44	+ 7-13	46	+ 4-54
		44	+ 9-77	46	+ 7-07	48	+ 4-49
		46	+ 9-71	48	+ 7-01	38-30	+ 4-44
		48	+ 9-65	37-40	+ 6-95	42	+ 4-38
		36-50	+ 9-59	42	+ 6-90	44	+ 4-33
		52	+ 9-53	44	+ 6-84	46	+ 4-28
		54	+ 9-47	46	+ 6-78	48	+ 4-22
		56	+ 9-41	48	+ 6-72	38-40	+ 4-17
		58	+ 9-35	37-50	+ 6-66	42	+ 4-11
		36-60	+ 9-29	52	+ 6-61	44	+ 4-06
		62	+ 9-23	54	+ 6-55	46	+ 4-00
		64	+ 9-17	56	+ 6-50	48	+ 3-95
		66	+ 9-11	58	+ 6-44	38-50	+ 3-90
		68	+ 9-05	37-60	+ 6-38	52	+ 3-84
		36-70	+ 8-99	62	+ 6-32	54	+ 3-78
		72	+ 8-93	64	+ 6-27	56	+ 3-73
		74	+ 8-87	66	+ 6-21	58	+ 3-68
		76	+ 8-81	68	+ 6-16	38-60	+ 3-63
		78	+ 8-76	37-70	+ 6-10	62	+ 3-57
		36-80	+ 8-70	72	+ 6-04	64	+ 3-52
		82	+ 8-64	74	+ 5-98	66	+ 3-46
		84	+ 8-58	76	+ 5-93	68	+ 3-41
		86	+ 8-52	78	+ 5-87	38-70	+ 3-36
		88	+ 8-46	37-80	+ 5-82	72	+ 3-31
		36-90	+ 8-40	82	+ 5-76	74	+ 3-25

Meter Registering 40 feet.		Meter Registering 40 feet.		Meter Registering 40 feet.		Meter Registering 40 feet.	
Reading of Scale of Gas Holder	Amount of Error.	Reading of Scale of Gas Holder	Amount of Error.	Reading of Scale of Gas Holder	Amount of Error.	Reading of Scale of Gas Holder	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
70	+ 3.20	68	+ 0.81	40.60	- 1.48	52	- 3.66
78	+ 3.14	39.70	+ 0.75	62	- 1.53	54	- 3.71
38.80	+ 3.09	72	+ 0.70	64	- 1.57	56	- 3.75
82	+ 3.04	74	+ 0.65	66	- 1.62	58	- 3.80
84	+ 2.99	76	+ 0.60	68	- 1.67	41.60	- 3.85
86	+ 2.93	78	+ 0.55	40.70	- 1.72	62	- 3.90
88	+ 2.88	39.80	+ 0.50	72	- 1.77	64	- 3.94
38.90	+ 2.82	82	+ 0.45	74	- 1.82	66	- 3.99
92	+ 2.77	84	+ 0.40	76	- 1.86	68	- 4.03
94	+ 2.72	86	+ 0.35	78	- 1.91	41.70	- 4.08
96	+ 2.67	88	+ 0.30	40.80	- 1.96	72	- 4.12
98	+ 2.61	39.90	+ 0.25	82	- 2.01	74	- 4.17
39.00	+ 2.56	92	+ 0.20	84	- 2.06	76	- 4.21
92	+ 2.51	94	+ 0.15	86	- 2.10	78	- 4.26
94	+ 2.46	96	+ 0.10	88	- 2.15	41.80	- 4.31
96	+ 2.40	98	+ 0.05	40.90	- 2.20	82	- 4.36
98	+ 2.35	40.00	Nil.	92	- 2.25	84	- 4.40
39.10	+ 2.30	92	- 0.05	94	- 2.30	86	- 4.45
12	+ 2.25	94	- 0.10	96	- 2.34	88	- 4.49
14	+ 2.20	96	- 0.15	98	- 2.39	41.90	- 4.54
16	+ 2.15	98	- 0.20	41.00	- 2.44	92	- 4.58
18	+ 2.09	40.10	- 0.25	92	- 2.49	94	- 4.63
39.20	+ 2.04	12	- 0.30	94	- 2.53	96	- 4.67
22	+ 1.99	14	- 0.35	96	- 2.58	98	- 4.72
24	+ 1.94	16	- 0.40	98	- 2.63	42.00	- 4.76
26	+ 1.88	18	- 0.45	41.10	- 2.68	92	- 4.81
28	+ 1.83	40.20	- 0.50	12	- 2.72	94	- 4.85
39.30	+ 1.78	22	- 0.55	14	- 2.78	96	- 4.90
32	+ 1.73	24	- 0.60	16	- 2.82	98	- 4.94
34	+ 1.68	26	- 0.65	18	- 2.87	42.10	- 4.99
36	+ 1.63	28	- 0.70	41.20	- 2.91	12	- 5.03
38	+ 1.57	40.30	- 0.75	22	- 2.96	14	- 5.08
39.40	+ 1.52	32	- 0.79	24	- 3.01	16	- 5.12
42	+ 1.47	34	- 0.84	26	- 3.06	18	- 5.17
44	+ 1.42	36	- 0.89	28	- 3.10	42.20	- 5.21
46	+ 1.37	38	- 0.94	41.30	- 3.15	22	- 5.26
48	+ 1.32	40.40	- 0.99	32	- 3.19	24	- 5.30
39.50	+ 1.26	42	- 1.04	34	- 3.24	26	- 5.35
52	+ 1.21	44	- 1.09	36	- 3.29	28	- 5.39
54	+ 1.16	46	- 1.14	38	- 3.34	42.30	- 5.44
56	+ 1.11	48	- 1.19	41.40	- 3.38	32	- 5.48
58	+ 1.06	40.50	- 1.24	42	- 3.43	34	- 5.53
39.60	+ 1.01	52	- 1.28	44	- 3.47	36	- 5.57
62	+ 0.96	54	- 1.33	46	- 3.52	38	- 5.62
64	+ 0.91	56	- 1.38	48	- 3.57	42.40	- 5.66
66	+ 0.86	58	- 1.43	41.50	- 3.61	42	- 5.71

Meter Registering 40 feet.		Meter Registering 40 feet.		Meter Registering 40 feet.		Meter Registering 50 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
44	- 5.75	36	- 7.75	28	- 9.67	45.00	+ 11.11
46	- 5.80	38	- 7.70	44.30	- 9.71	02	+ 11.06
48	- 5.84	43.40	- 7.83	32	- 9.75	04	+ 11.01
42.50	- 5.88	42	- 7.88	34	- 9.79	06	+ 10.96
52	- 5.93	44	- 7.92	36	- 9.83	08	+ 10.91
54	- 5.98	46	- 7.96	38	- 9.87	45.10	+ 10.86
56	- 6.02	48	- 8.00	44.40	- 9.91	12	+ 10.81
58	- 6.06	43.50	- 8.05	42	- 9.95	14	+ 10.76
42.60	- 6.10	52	- 8.09	44	- 9.99	16	+ 10.72
62	- 6.15	54	- 8.13	46	- 10.03	18	+ 10.67
64	- 6.19	56	- 8.17	48	- 10.07	45.20	+ 10.62
66	- 6.24	58	- 8.22	44.50	- 10.11	22	+ 10.57
68	- 6.28	43.60	- 8.26	52	- 10.15	24	+ 10.52
42.70	- 6.33	62	- 8.30	54	- 10.19	26	+ 10.48
72	- 6.37	64	- 8.34	56	- 10.23	28	+ 10.43
74	- 6.41	66	- 8.38	58	- 10.27	45.30	+ 10.38
76	- 6.45	68	- 8.42	44.60	- 10.31	32	+ 10.33
78	- 6.50	43.70	- 8.47	62	- 10.35	34	+ 10.28
42.80	- 6.54	72	- 8.51	64	- 10.39	36	+ 10.23
82	- 6.59	74	- 8.55	66	- 10.43	38	+ 10.18
84	- 6.63	76	- 8.59	68	- 10.47	45.40	+ 10.13
86	- 6.68	78	- 8.64	44.70	- 10.51	42	+ 10.08
88	- 6.72	43.80	- 8.68	72	- 10.55	44	+ 10.03
42.90	- 6.76	82	- 8.72	74	- 10.59	46	+ 9.99
92	- 6.80	84	- 8.76	76	- 10.63	48	+ 9.94
94	- 6.85	86	- 8.80	78	- 10.67	45.50	+ 9.89
96	- 6.89	88	- 8.84	44.80	- 10.71	52	+ 9.84
98	- 6.94	43.90	- 8.89	82	- 10.75	54	+ 9.79
43.00	- 6.98	92	- 8.93	84	- 10.79	56	+ 9.75
02	- 7.02	94	- 8.97	86	- 10.84	58	+ 9.70
04	- 7.06	96	- 9.01	88	- 10.87	45.60	+ 9.65
06	- 7.11	98	- 9.05	44.90	- 10.91	62	+ 9.60
08	- 7.15	44.00	- 9.09	92	- 10.95	64	+ 9.55
43.10	- 7.20	02	- 9.14	94	- 10.99	66	+ 9.51
12	- 7.24	04	- 9.18	96	- 11.03	68	+ 9.46
14	- 7.28	06	- 9.22	98	- 11.07	45.70	+ 9.41
16	- 7.32	08	- 9.26	45.00	- 11.11	72	+ 9.36
18	- 7.37	44.10	- 9.30			74	+ 9.31
43.20	- 7.41	12	- 9.34			76	+ 9.27
22	- 7.45	14	- 9.38			78	+ 9.22
24	- 7.49	16	- 9.42			45.80	+ 9.17
26	- 7.54	18	- 9.47			82	+ 9.12
28	- 7.58	44.20	- 9.51			84	+ 9.07
42.30	- 7.62	22	- 9.55			86	+ 9.03
32	- 7.66	24	- 9.59			88	+ 8.98
34	- 7.71	26	- 9.63			45.90	+ 8.93

Meter Registering 50 feet.		Meter Registering 50 feet.		Meter Registering 50 feet.		Meter Registering 50 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
·02	+ 8·88	·84	+ 6·75	·76	+ 4·69	·68	+ 2·71
·04	+ 8·84	·86	+ 6·70	·78	+ 4·64	48·70	+ 2·67
·06	+ 8·79	·88	+ 6·66	47·80	+ 4·60	·72	+ 2·63
·08	+ 8·75	46·90	+ 6·61	·82	+ 4·56	·74	+ 2·59
46·00	+ 8·70	·92	+ 6·56	·84	+ 4·51	·76	+ 2·54
·02	+ 8·65	·94	+ 6·52	·86	+ 4·47	·78	+ 2·50
·04	+ 8·60	·96	+ 6·47	·88	+ 4·42	48·80	+ 2·46
·06	+ 8·56	·98	+ 6·43	47·90	+ 4·38	·82	+ 2·42
·08	+ 8·51	47·00	+ 6·38	·92	+ 4·34	·84	+ 2·38
46·10	+ 8·46	·02	+ 6·34	·94	+ 4·30	·86	+ 2·33
·12	+ 8·41	·04	+ 6·29	·96	+ 4·25	·88	+ 2·29
·14	+ 8·37	·06	+ 6·25	·98	+ 4·21	48·90	+ 2·25
·16	+ 8·32	·08	+ 6·20	48·00	+ 4·17	·92	+ 2·21
·18	+ 8·28	47·10	+ 6·16	·02	+ 4·13	·94	+ 2·17
46·20	+ 8·23	·12	+ 6·11	·04	+ 4·08	·96	+ 2·12
·22	+ 8·18	·14	+ 6·07	·06	+ 4·04	·98	+ 2·08
·24	+ 8·13	·16	+ 6·02	·08	+ 3·99	49·00	+ 2·04
·26	+ 8·09	·18	+ 5·98	48·10	+ 3·95	·02	+ 2·00
·28	+ 8·04	47·20	+ 5·93	·12	+ 3·91	·04	+ 1·96
46·30	+ 7·99	·22	+ 5·89	·14	+ 3·86	·06	+ 1·91
·32	+ 7·94	·24	+ 5·84	·16	+ 3·82	·08	+ 1·87
·34	+ 7·90	·26	+ 5·80	·18	+ 3·77	49·10	+ 1·83
·36	+ 7·85	·28	+ 5·75	48·20	+ 3·73	·12	+ 1·79
·38	+ 7·81	47·30	+ 5·71	·22	+ 3·69	·14	+ 1·75
46·40	+ 7·76	·32	+ 5·67	·24	+ 3·65	·16	+ 1·71
·42	+ 7·71	·34	+ 5·62	·26	+ 3·60	·18	+ 1·67
·44	+ 7·67	·36	+ 5·58	·28	+ 3·56	49·20	+ 1·63
·46	+ 7·62	·38	+ 5·53	48·30	+ 3·52	·22	+ 1·59
·48	+ 7·58	47·40	+ 5·49	·32	+ 3·48	·24	+ 1·55
46·50	+ 7·53	·42	+ 5·44	·34	+ 3·44	·26	+ 1·50
·52	+ 7·48	·44	+ 5·40	·36	+ 3·39	·28	+ 1·46
·54	+ 7·44	·46	+ 5·35	·38	+ 3·35	49·30	+ 1·42
·56	+ 7·39	·48	+ 5·31	48·40	+ 3·31	·32	+ 1·38
·58	+ 7·35	47·50	+ 5·26	·42	+ 3·27	·34	+ 1·34
46·60	+ 7·30	·52	+ 5·22	·44	+ 3·22	·36	+ 1·29
·62	+ 7·25	·54	+ 5·17	·46	+ 3·18	·38	+ 1·25
·64	+ 7·21	·56	+ 5·13	·48	+ 3·13	49·40	+ 1·21
·66	+ 7·16	·58	+ 5·08	48·50	+ 3·09	·42	+ 1·17
·68	+ 7·12	47·60	+ 5·04	·52	+ 3·05	·44	+ 1·13
46·70	+ 7·07	·62	+ 5·00	·54	+ 3·01	·46	+ 1·09
·72	+ 7·02	·64	+ 4·95	·56	+ 2·96	·48	+ 1·05
·74	+ 6·98	·66	+ 4·91	·58	+ 2·92	49·50	+ 1·01
·76	+ 6·93	·68	+ 4·86	48·60	+ 2·88	·52	+ 0·97
·78	+ 6·89	47·70	+ 4·82	·62	+ 2·84	·54	+ 0·93
46·80	+ 6·84	·72	+ 4·78	·64	+ 2·80	·56	+ 0·89
·82	+ 6·79	·74	+ 4·73	·66	+ 2·75	·58	+ 0·85

Meter Registering 50 feet.		Meter Registering 50 feet.		Meter Registering 50 feet.		Meter Registering 50 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
49-60	+ 0-81	52	- 1-03	44	- 2-80	90	- 5-48
62	+ 0-77	54	- 1-07	46	- 2-83	95	- 5-57
64	+ 0-73	56	- 1-11	48	- 2-87	53-00	- 5-06
66	+ 0-68	58	- 1-15	51-50	- 2-91	05	- 5-75
68	+ 0-64	50-60	- 1-19	52	- 2-95	10	- 5-84
49-70	+ 0-60	62	- 1-23	54	- 2-99	15	- 5-93
72	+ 0-56	64	- 1-27	56	- 3-02	20	- 6-02
74	+ 0-52	66	- 1-30	58	- 3-06	25	- 6-10
76	+ 0-48	68	- 1-34	51-60	- 3-10	30	- 6-19
78	+ 0-44	50-70	- 1-38	62	- 3-14	35	- 6-28
49-80	+ 0-40	72	- 1-42	64	- 3-18	40	- 6-37
82	+ 0-36	74	- 1-46	66	- 3-21	45	- 6-45
84	+ 0-32	76	- 1-49	68	- 3-25	53-50	- 6-54
86	+ 0-28	78	- 1-53	51-70	- 3-29	55	- 6-63
88	+ 0-24	50-80	- 1-57	72	- 3-33	60	- 6-72
49-90	+ 0-20	82	- 1-61	74	- 3-36	65	- 6-80
92	+ 0-16	84	- 1-65	76	- 3-40	70	- 6-89
94	+ 0-12	86	- 1-69	78	- 3-43	75	- 6-98
96	+ 0-08	88	- 1-73	51-80	- 3-47	80	- 7-06
98	+ 0-04	50-90	- 1-77	82	- 3-51	85	- 7-15
50-00	Nil.	92	- 1-81	84	- 3-55	90	- 7-24
02	- 0-04	94	- 1-85	86	- 3-58	95	- 7-32
04	- 0-08	96	- 1-88	88	- 3-62	54-00	- 7-41
06	- 0-12	98	- 1-92	51-90	- 3-66	05	- 7-49
08	- 0-16	51-00	- 1-96	92	- 3-70	10	- 7-58
50-10	- 0-20	02	- 2-00	94	- 3-74	15	- 7-66
12	- 0-24	04	- 2-04	96	- 3-77	20	- 7-75
14	- 0-28	06	- 2-07	98	- 3-81	25	- 7-83
16	- 0-32	08	- 2-11	52-00	- 3-85	30	- 7-92
18	- 0-36	51-10	- 2-15	05	- 3-94	35	- 8-00
50-20	- 0-40	12	- 2-19	10	- 4-03	40	- 8-09
22	- 0-44	14	- 2-23	15	- 4-12	45	- 8-17
24	- 0-48	16	- 2-26	20	- 4-21	54-50	- 8-26
26	- 0-52	18	- 2-30	25	- 4-31	55	- 8-34
28	- 0-56	51-20	- 2-34	30	- 4-40	60	- 8-42
50-30	- 0-60	22	- 2-38	35	- 4-49	65	- 8-51
32	- 0-64	24	- 2-42	40	- 4-58	70	- 8-59
34	- 0-68	26	- 2-45	45	- 4-67	75	- 8-68
36	- 0-71	28	- 2-49	52-50	- 4-76	80	- 8-76
38	- 0-75	51-30	- 2-53	55	- 4-85	85	- 8-84
50-40	- 0-79	32	- 2-57	60	- 4-94	90	- 8-93
42	- 0-83	34	- 2-61	65	- 5-03	95	- 9-01
44	- 0-87	36	- 2-65	70	- 5-12	55-00	- 9-19
46	- 0-91	38	- 2-69	75	- 5-21	05	- 9-18
48	- 0-95	51-40	- 2-72	80	- 5-30	10	- 9-26
50-50	- 0-99	42	- 2-76	85	- 5-39	15	- 9-34

Meter Registering 50 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.	
Reading of Scale of Gas Holder	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
20	- 9.42	90.00	+ 11.11	30	+ 8.34	60	+ 5.71
25	- 9.51	05	+ 11.05	35	+ 8.29	65	+ 5.65
30	- 9.59	10	+ 10.99	40	+ 8.23	70	+ 5.60
35	- 9.67	15	+ 10.92	45	+ 8.17	75	+ 5.54
40	- 9.75	20	+ 10.86	50	+ 8.11	80	+ 5.49
45	- 9.83	25	+ 10.80	55	+ 8.05	85	+ 5.43
50	- 9.91	30	+ 10.74	60	+ 7.99	90	+ 5.37
55	- 9.99	35	+ 10.68	65	+ 7.93	95	+ 5.31
60	- 10.07	40	+ 10.62	70	+ 7.87	95.00	+ 5.26
65	- 10.15	45	+ 10.56	75	+ 7.82	05	+ 5.20
70	- 10.23	50	+ 10.50	80	+ 7.76	10	+ 5.15
75	- 10.31	55	+ 10.44	85	+ 7.70	15	+ 5.09
80	- 10.39	60	+ 10.38	90	+ 7.64	20	+ 5.04
85	- 10.47	65	+ 10.31	95	+ 7.58	25	+ 4.98
90	- 10.55	70	+ 10.25	93.00	+ 7.53	30	+ 4.93
95	- 10.63	75	+ 10.19	05	+ 7.47	35	+ 4.87
50.00	- 10.71	80	+ 10.13	10	+ 7.41	40	+ 4.82
05	- 10.79	85	+ 10.07	15	+ 7.36	45	+ 4.76
10	- 10.87	90	+ 10.01	20	+ 7.30	50	+ 4.71
15	- 10.95	95	+ 9.95	25	+ 7.24	55	+ 4.65
20	- 11.03	91.00	+ 9.89	30	+ 7.18	60	+ 4.60
25	- 11.11	05	+ 9.83	35	+ 7.13	65	+ 4.54
		10	+ 9.77	40	+ 7.07	70	+ 4.49
		15	+ 9.71	45	+ 7.01	75	+ 4.43
		20	+ 9.65	50	+ 6.95	80	+ 4.38
		25	+ 9.59	55	+ 6.90	85	+ 4.33
		30	+ 9.53	60	+ 6.84	90	+ 4.28
		35	+ 9.47	65	+ 6.78	95	+ 4.22
		40	+ 9.41	70	+ 6.72	96.00	+ 4.17
		45	+ 9.35	75	+ 6.66	05	+ 4.11
		50	+ 9.29	80	+ 6.61	10	+ 4.06
		55	+ 9.23	85	+ 6.55	15	+ 4.00
		60	+ 9.17	90	+ 6.50	20	+ 3.95
		65	+ 9.11	95	+ 6.44	25	+ 3.89
		70	+ 9.05	94.00	+ 6.38	30	+ 3.84
		75	+ 8.99	05	+ 6.32	35	+ 3.78
		80	+ 8.93	10	+ 6.27	40	+ 3.73
		85	+ 8.87	15	+ 6.21	45	+ 3.68
		90	+ 8.81	20	+ 6.16	50	+ 3.63
		95	+ 8.76	25	+ 6.10	55	+ 3.57
		92.00	+ 8.70	30	+ 6.04	60	+ 3.52
		05	+ 8.64	35	+ 5.98	65	+ 3.46
		10	+ 8.58	40	+ 5.93	70	+ 3.41
		15	+ 8.52	45	+ 5.87	75	+ 3.36
		20	+ 8.46	50	+ 5.82	80	+ 3.31
		25	+ 8.40	55	+ 5.76	85	+ 3.25

Meter Registering 100 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
00	+ 3.20	20	+ 0.81	101.50	- 1.48	80	- 3.66
05	+ 3.14	25	+ 0.75	55	- 1.53	85	- 3.71
97.00	+ 3.09	30	+ 0.70	60	- 1.57	90	- 3.75
05	+ 3.04	35	+ 0.65	65	- 1.62	95	- 3.80
10	+ 2.99	40	+ 0.60	70	- 1.67	104.00	- 3.85
15	+ 2.93	45	+ 0.55	75	- 1.72	05	- 3.90
20	+ 2.88	99.50	+ 0.50	80	- 1.77	10	- 3.94
25	+ 2.82	55	+ 0.45	85	- 1.82	15	- 3.99
30	+ 2.77	60	+ 0.40	90	- 1.87	20	- 4.03
35	+ 2.72	65	+ 0.35	95	- 1.91	25	- 4.08
40	+ 2.67	70	+ 0.30	102.00	- 1.96	30	- 4.12
45	+ 2.61	75	+ 0.25	05	- 2.01	35	- 4.17
97.50	+ 2.56	80	+ 0.20	10	- 2.06	40	- 4.21
55	+ 2.51	85	+ 0.15	15	- 2.10	45	- 4.26
60	+ 2.46	90	+ 0.10	20	- 2.15	104.50	- 4.31
65	+ 2.40	95	+ 0.05	25	- 2.20	55	- 4.36
70	+ 2.35	100.00	Nil.	30	- 2.25	60	- 4.40
75	+ 2.30	05	- 0.05	35	- 2.30	65	- 4.45
80	+ 2.25	10	- 0.10	40	- 2.34	70	- 4.49
85	+ 2.20	15	- 0.15	45	- 2.39	75	- 4.54
90	+ 2.15	20	- 0.20	102.50	- 2.44	80	- 4.58
95	+ 2.09	25	- 0.25	55	- 2.49	85	- 4.63
98.00	+ 2.04	30	- 0.30	60	- 2.53	90	- 4.67
05	+ 1.99	35	- 0.35	65	- 2.58	95	- 4.72
10	+ 1.94	40	- 0.40	70	- 2.63	105.00	- 4.76
15	+ 1.88	45	- 0.45	75	- 2.68	05	- 4.81
20	+ 1.83	100.50	- 0.50	80	- 2.72	10	- 4.85
25	+ 1.78	55	- 0.55	85	- 2.78	15	- 4.90
30	+ 1.73	60	- 0.60	90	- 2.82	20	- 4.94
35	+ 1.68	65	- 0.65	95	- 2.87	25	- 4.99
40	+ 1.63	70	- 0.70	103.00	- 2.91	30	- 5.03
45	+ 1.57	75	- 0.75	05	- 2.96	35	- 5.08
98.50	+ 1.52	80	- 0.79	10	- 3.01	40	- 5.12
55	+ 1.47	85	- 0.84	15	- 3.06	45	- 5.17
60	+ 1.42	90	- 0.89	20	- 3.10	105.50	- 5.21
65	+ 1.37	95	- 0.94	25	- 3.15	55	- 5.26
70	+ 1.32	101.00	- 0.99	30	- 3.19	60	- 5.30
75	+ 1.26	05	- 1.04	35	- 3.24	65	- 5.35
80	+ 1.21	10	- 1.09	40	- 3.29	70	- 5.39
85	+ 1.16	15	- 1.14	45	- 3.34	75	- 5.44
90	+ 1.11	20	- 1.19	103.50	- 3.38	80	- 5.48
95	+ 1.06	25	- 1.24	55	- 3.43	85	- 5.53
99.00	+ 1.01	30	- 1.28	60	- 3.47	90	- 5.57
05	+ 0.96	35	- 1.33	65	- 3.52	95	- 5.62
10	+ 0.91	40	- 1.38	70	- 3.57	106.00	- 5.66
15	+ 0.86	45	- 1.43	75	- 3.61	05	- 5.71

Meter Registering 100 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.		Meter Registering 100 feet.	
Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.	Reading of Scale of Gas Holder.	Amount of Error.
Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.	Feet.	Per Cent.
10	— 5.75	40	— 6.89	70	— 8.00	110.00	— 9.09
15	— 5.80	45	— 6.94	75	— 8.05	110	— 9.18
20	— 5.84	107.50	— 6.98	80	— 8.09	120	— 9.26
25	— 5.88	55	— 7.02	85	— 8.13	130	— 9.34
30	— 5.93	60	— 7.06	90	— 8.17	140	— 9.42
35	— 5.98	65	— 7.11	95	— 8.22	150	— 9.51
40	— 6.02	70	— 7.15	100.00	— 8.26	160	— 9.59
45	— 6.06	75	— 7.20	05	— 8.30	170	— 9.67
106.50	— 6.10	80	— 7.24	10	— 8.34	180	— 9.75
55	— 6.15	85	— 7.28	15	— 8.38	190	— 9.83
60	— 6.19	90	— 7.32	20	— 8.42	111.00	— 9.91
65	— 6.24	95	— 7.37	25	— 8.47	110	— 9.99
70	— 6.28	108.00	— 7.41	30	— 8.51	120	— 10.07
75	— 6.33	05	— 7.45	35	— 8.55	130	— 10.15
80	— 6.37	10	— 7.49	40	— 8.59	140	— 10.23
85	— 6.41	15	— 7.54	45	— 8.64	150	— 10.31
90	— 6.45	20	— 7.58	109.50	— 8.68	160	— 10.39
95	— 6.50	25	— 7.62	55	— 8.72	170	— 10.47
107.00	— 6.54	30	— 7.66	60	— 8.76	180	— 10.55
05	— 6.59	35	— 7.71	65	— 8.80	190	— 10.63
10	— 6.63	40	— 7.75	70	— 8.84	112.00	— 10.71
15	— 6.68	45	— 7.79	75	— 8.89	110	— 10.79
20	— 6.72	108.50	— 7.83	80	— 8.93	120	— 10.87
25	— 6.76	55	— 7.88	85	— 8.97	130	— 10.95
30	— 6.80	60	— 7.92	90	— 9.01	140	— 11.03
35	— 6.85	65	— 7.96	95	— 9.05	150	— 11.11

[A.] GAS METER TESTING STATION Register of Gas Meters

tested pursuant to Act 22 and 23 Vic., c. 66, and Account of Fees thereupon.

Date of Receiving the Meter.	Name of Maker.	Wet or Dry.	No. of Meter.	No. of Lights.	Reading of Index.	Capacity at one Revolution or Complete Action	Date of Testing.	Quantity of Gas or Air passed.				Maximum per cent. of error in		Fees.			Remarks.	
								Registration of Meter at each Trial.	Registration of Holder.		On each Meter.	Buyer.	Seller.	Amount.	No. of Receipts.	Amount.		Carried to Ledger Account.
									Water line in Meter.	Dry Meters.								
1882.	Brought forward	W	9670	25	Zero.	25	1882.	9-95	10-23	...	0-30	2-25	0 0 6	0 0 6	64			
June 19	Brown & Co. ...	"	9671	"	"	"	June 20	10 ft.	9-93	10-30	...	0-70	2-01	0 0 6	...	...		
" "	" " " "	"	9672	"	"	"	" "	" "	9-91	10-24	...	0-91	2-34	0 0 6	...	...		
" "	" " " "	"	10290	20	"	1-0	" "	" "	18-71	20-30	...	1-47	2-44	0 1 0	...	...		
" 27	White " " "	D	4080	10	"	2-77	" "	" "	...	...	...	9-90	1-01	0 1 0	6 700	0 1 0	96	
" 28	Stanley " " "	D	17086	30	17,900	8-05	" "	" "	...	...	...	...	...	0 1 0	1 0 0	...	...	
" "	Bryan " " "	D	784	50	120,700	1-0	" "	" "	...	...	...	...	...	0 1 0	1 0 0	...	...	
1-1	1-80	0-5	1-0	0-6	0-975	0-5	0-80	0-75	0-7	0-7	0-7	0-7	1-0	1-75	1-4	4-0		

NOTE.—Size of Sheet, 19½ by 13 inches. Widths of Headings and Columns as marked in inches and parts. Number of Lines below Heading, 26. Headings are printed in horizontal lines, and not vertically as so are in this Table.

[B.]

Metropolitan Board of Works.

METER INSPECTOR'S OFFICE,

ST. ANN'S STREET, WESTMINSTER.

18

STATEMENT OF FEES RECEIVED AND AMOUNTS OUTSTANDING.

WEEK ENDING

Amount outstanding as per last Return	. £
Amount of Fees during the week	. .
	£
Cash herewith	. . .
Balance outstanding	. . £

Viz.—Owing by

Folio.....	 £
.....	
.....	
.....	
.....	
.....	
	£

Size of Sheet, 13 by 8 inches.

Inspector.

GAS METER INSPECTOR'S OFFICE,

ST. ANN'S STREET, WESTMINSTER, S.W.

M

To the Metropolitan Board of Works.

Fees for Testing Meters under Sale of Gas Acts.

[illegible]

Size of Sheet, 13 by 8 inches.

[D.]

METER INSPECTOR'S OFFICE,
ST. ANN'S STREET, WESTMINSTER, S.W.

I hereby Certify that the Light
Meter No. Index was examined and
tested by me on the day of
18 , in accordance with the rules provided in the 12th and
13th Sections of the Sale of Gas Act, 1859, and having been
found to register
has been by me

Witness my hand,

Inspector of Meters.

NOTICE.—By the 22nd and 23rd Victoria, Cap. 66, it is enacted—That
any person using or fixing an Unstamped Meter is liable to a penalty
of **Five Pounds**.

Size of Sheet, 10 by 8 inches.

METER INSPECTORS OFFICE,

If I hereby Certify that the Meters hereinafter described were examined and tested by me
on the _____ day of _____ 187____, in accordance with the Rules provided
in the 12th and 13th Sections of the Sale of Gas Act, 1859.

INDEX.

NUMBER.

MAKER.

No. OF
LIGHTS.

Will not Register per hour.	Remarks.

Fast.

Slow.

Register
per hour.

Remarks.

Witness my hand,

Inspector of Meters.

Size of Sheet, 13 by 8 inches. 21 Lines under Heading.

ADVERTISEMENTS.

ALEX^R. WRIGHT & Co.,

**55, 55a, and 56, MILLBANK STREET,
LONDON, S.W.,**

**Engineers and Manufacturers of
GAS METERS**

OF THE MOST PERFECT CONSTRUCTION, AS SUPPLIED FOR MANY
YEARS TO THE

**Gas Light and Coke Company, and to other London,
Provincial, and Continental Gas Companies.**

WRIGHT & CO.'s DRY METERS

Are surpassed by those of no other Maker, and are
more substantial than most Dry Meters.

WRIGHT & CO.'s WET METERS

Have received the testimony of 28 years' extensive use, and their construction has been copied by many Meter Makers. They ensure accurate measurement by compensation, i.e., by maintaining the water level at its proper height. Compensation in a Consumer's Meter is generally essential, and a Meter is a "Compensator," whether the compensation be effected by *water* or by *gas*. That Meter is the best *which works with the least friction*, which is *least complex*, and may be *most readily cleaned or repaired* when needful. These conditions are satisfied with A. WRIGHT & CO.'s Wet Meters.

LISTS ON APPLICATION.

ALEXANDER WRIGHT & Co., Engineers.

**STATION GAS METERS,
STATION GAS GOVERNORS,
*JONES' THROTTLE VALVE STATION
GOVERNORS.***

JONES' DIFFERENTIAL GOVERNORS.

The most *Simple* and *Perfect* acting Governors
for reducing excessive pressure in Hilly Districts.

CONSUMERS' GAS GOVERNORS.

PRESSURE AND EXHAUST REGULATORS.

**Exhaust Registers, Pressure Registers,
Wright's Registering Gauges,
King's Gauges,**

AND

PRESSURE GAUGES OF ALL KINDS.

LISTS ON APPLICATION.

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**Improved Lamp Meters,
AND
Lamp Meter Boxes,
Street Lamp Regulators,
Lever Lantern Cocks, &c.,**

**AS SUPPLIED BY A. WRIGHT & Co., TO THE
VESTRY OF ST. GEORGE,
HANOVER SQUARE,
ALSO TO OTHER
PUBLIC AUTHORITIES,
AND NOW IN SATISFACTORY OPERATION.**

**STREET LANTERNS, LIGHTING RODS,
AND
ALL REQUIREMENTS FOR
PUBLIC LIGHTING.**

LISTS ON APPLICATION.

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**REQUIRED FOR THE
ANALYSIS OF COAL GAS.**

**STANDARD
PHOTOMETERS, METERS, GOVERNORS, &c.,**

AS APPROVED BY THE

**GAS REFEREES and used by them at their Offices, and
every kind of Instrument necessary in the deter-
mination of the**

ILLUMINATING POWER & PURITY OF COAL GAS.

**SOLE AUTHORIZED MAKERS OF
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For use with ORDINARY or with CARBURETTED GASES.

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PENTANE or AIR-GAS STANDARD**

AND

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As Made by A. WRIGHT & Co. for the Gas Referees.

**PHOTOMETERS
FOR SPECIAL PURPOSES TO ORDER.**

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A. WRIGHT & Co. ARE THE DESIGNERS AND MAKERS
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The STANDARD GASHOLDERS,
The STANDARD GAS METERS, &c., &c.,

FOR THE

Governments of Canada, South
Australia and the Netherlands.

THEY ALSO MADE AND SUPPLIED THE WHOLE OF THE

GAS METER-TESTING APPARATUS

FOR THE

DOMINION OF CANADA.

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ALEXANDER WRIGHT & Co., Engineers.

" STANDARDS DEPARTMENT,

" BOARD OF TRADE,

" 2nd June, 1875.

" GENTLEMEN,

" This Department having been informed by Mr. Newport that the verification of the Inspection Gas Measuring Standards for Canada is now completed, I am desirous to convey to you the satisfaction of this Department at the manner in which the work connected with these Standards has been executed.

" I am also to inform you that this Department has this day telegraphed to Mr. Brunel the completion of the verification of these Standards.

" I am, Gentlemen,

" Your obedient Servant,

(Signed) " H. J. CHANEY.

" Messrs. A. WRIGHT & Co.,

" 55, Millbank Street, Westminster."

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